

CHAPTER - 21



MITIGATION STRATEGIES

21.1. CARBON SEQUESTRATION:

- Carbon capture and storage, also known as CCS or carbon sequestration, describes the technologies designed to tackle global warming by capturing CO₂ at power stations, industrial sites or even directly from the air and permanently storing it underground.
- Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming.
- It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels.

21.1.1. Sinks

- Carbon sequestration may be carried out by pumping carbon into 'carbon sinks'— an area that absorbs carbon.
 - Natural sinks - Oceans, forests, soil etc.
 - Artificial sinks - Depleted oil reserves, unmineable mines, etc.
- Carbon capture has actually been in use for years. The oil and gas industries have used carbon capture for decades as a way to enhance oil and gas recovery. Only recently have we started thinking about capturing carbon for environmental reasons.

There are three main steps to carbon capture and storage (CCS) -

- trapping and separating the CO₂ from other gases,

- transporting this captured CO₂ to a storage location, and
- storing that CO₂ far away from the atmosphere (underground or deep in the ocean).

21.1.2. Types of Sequestration:

- There are number of technologies under investigation for sequestering carbon from the atmosphere. These can be discussed under three main categories:
- Ocean Sequestration:** Carbon stored in oceans through direct injection or fertilization.
- Geologic Sequestration:** Natural pore spaces in geologic formations serve as reservoirs for long-term carbon dioxide storage.
- Terrestrial Sequestration:** A large amount of carbon is stored in soils and vegetation, which are our natural carbon sinks. Increasing carbon fixation through photosynthesis, slowing down or reducing decomposition of organic matter, and changing land use practices can enhance carbon uptake in these natural sinks.
- Geologic Sequestration is thought to have the largest potential for near-term application.

Geologic Sequestration Trapping Mechanisms

- Hydrodynamic Trapping:** Carbon dioxide can be trapped as a gas under low-permeability cap rock (much like natural gas is stored in gas reservoirs).
- Solubility Trapping:** Carbon dioxide can be dissolved into a liquid, such as water or oil.



- **Mineral Carbonation:** Carbon dioxide can react with the minerals, fluids, and organic matter in a geologic formation to form stable compounds/minerals; largely calcium, iron, and magnesium carbonates.
- Carbon dioxide can be effectively stored in the earth's subsurface by hydrodynamic trapping and solubility trapping - usually a combination of the two is most effective.

21.1.3 Carbon Capture, Utilization and Storage

NITI Aayog has introduced a policy framework for Carbon Capture, Utilisation, and Storage (CCUS) along with its implementation mechanism in India.

Objectives

- Aims to develop and implement a practicable framework to accelerate research and development on CCUS in India.
- Explores the importance of the technology as an emission reduction strategy to achieve deep decarbonization from the hard-to-abate sectors like steel, cement etc.

Features

- CCUS comprises techniques and technologies designed to extract carbon dioxide (CO₂) from both flue gas emissions and the atmosphere, followed by recycling the CO₂ for utilization and determining safe and permanent storage options.
- The CO₂ obtained through CCUS methods is transformed into valuable products like fuel (methane and methanol), refrigerants, and materials used in construction.
- CCUS offers a diverse range of opportunities for converting captured CO₂ into value-added products such as green urea, applications in the food and beverage industry, building materials, chemicals like methanol and ethanol, polymers including bio-plastics, and enhanced oil recovery (EOR). These opportunities hold substantial market potential in India and can make a significant contribution to a circular economy.

- CCUS projects are expected to generate significant employment opportunities. It is estimated that by capturing approximately 750 million metric tons per annum (mtpa) of carbon by 2050, it could create employment for 8-10 million individuals on a full-time equivalent (FTE) basis in a phased manner.

21.2. CARBON SINK

- Unlike black and brown carbon that contribute to atmospheric green house gases, green and blue carbon sequester the atmosphere green house gases

21.2.1. Green Carbon

- Green carbon is carbon removed by photosynthesis and stored in the plants and soil of natural ecosystems and is a vital part of the global carbon cycle.
- Many plants and most crops, have short lives and release much of their carbon at the end of each season, but forest biomass accumulates carbon over decades and centuries.
- Furthermore, forests can accumulate large amounts of CO₂ in relatively short periods, typically several decades.
- Afforestation and reforestation are measures that can be taken to enhance biological carbon sequestration.

21.2.2. Blue Carbon

- Blue Carbon refers to coastal, aquatic and marine carbon sinks held by the indicative vegetation, marine organism and sediments.
- In particular, coastal ecosystems such as tidal marshes, mangroves, and seagrasses remove carbon from the atmosphere and ocean, storing it in plants and depositing it in the sediment below them by natural processes.
- These coastal ecosystems are very efficient at sequestering and storing carbon - each square mile of these systems can remove carbon from the atmosphere and oceans at rates higher than each square mile of mature tropical forests.



- Furthermore, coastal ecosystems have been found to store huge quantities of carbon in organic rich sediments - up to 5 times more carbon than many temperate and tropical forests.
- These ecosystems are found in all continents, except Antarctica.

Why is Blue Carbon Ecosystem Important?

- Preventing degradation and destruction and promoting restoration of coastal ecosystems is a significant tool to mitigate climate change.
- The coastal ecosystems of mangroves, tidal marshes, and seagrasses are some of the most rapidly disappearing natural systems on Earth.

When lost they not only stop sequestering carbon but also release their stores of carbon and become new sources of climate change causing carbon emissions which can last for centuries.

The Blue Carbon Initiative

- The Blue Carbon Initiative is the first integrated program with a comprehensive and coordinated global agenda focused on mitigating climate change through the conservation and restoration of coastal marine ecosystems.

21.2.3. International Cooperation

Conservation International (CI), the International Union for Conservation of Nature (IUCN), and the Intergovernmental Oceanic Commission (IOC) of UNESCO is collaborating with governments, research institutions, non-governmental and international organizations, and communities around the world to

- Develop management approaches, financial incentives and policy mechanisms for ensuring conservation and restoration of coastal Blue Carbon ecosystems;
- Engage local, national, and international governments to ensure policies and regulations support coastal Blue Carbon conservation, management and financing;
- Develop comprehensive methods for coastal carbon accounting;

- Develop incentive mechanisms such as carbon payment schemes for Blue Carbon projects; and
- Implement projects around the world that demonstrate the feasibility of coastal Blue Carbon accounting, management, and incentive agreements;
- Support scientific research into the role and importance of coastal Blue Carbon ecosystems for climate change mitigation.

21.3. CARBON CREDIT:

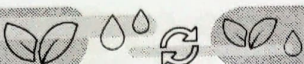
- A carbon credit is a tradeable certificate or permit representing the right to emit one tonne of carbon or carbon dioxide equivalent (tCO₂e).
- One carbon credit is equal to one ton of carbon dioxide, or in some markets, carbon dioxide equivalent gases.

How does one earn a carbon credit?

- An organisation which produces one tonne less of carbon or carbon dioxide equivalent than the standard level of carbon emission allowed for its outfit or activity, earns a carbon credit.

How does it help?

- Countries which are signatories to the Kyoto Protocol under the UNFCCC have laid down gas emission norms for their companies to be met by 2012. In such cases, a company has two ways to reduce emissions.
 - (i) It can reduce the GHG (greenhouse gases) by adopting new technology or improving upon the existing technology to attain the new norms for emission of gases.
 - (ii) It can tie up with developing nations and help them set up new technology that is eco-friendly, thereby helping developing country or its companies 'earn' credits. This credit becomes a permit for the company to emit GHGs in its own country. However, only a portion of carbon credits of the company in developing country can be transferred to the company in developed country.



Developing countries

- Developing countries like India and China are likely to emerge as the biggest sellers and Europe is going to be the biggest buyers of carbon credits.
- Last year global carbon credit trading was estimated at \$5 billion, with India's contribution at around \$1 billion.
- China is currently the largest seller of carbon credits controlling about 70% of the market share.
- Carbon, like any other commodity, has begun to be traded on India's Multi Commodity Exchange.
- MCX has become first exchange in Asia to trade carbon credits.

21.4. CARBON OFFSETTING:

- Carbon offsets are credits for reductions in greenhouse gas emissions made at another location, such as wind farms which create renewable energy and reduce the need for fossil-fuel powered energy.
- Carbon offsets are quantified and sold in metric tonnes of carbon dioxide equivalent (CO_2e).
- Buying one tonne of carbon offsets means there will be one less tonne of carbon dioxide in the atmosphere than there would otherwise have been.
- Carbon offsetting is often the fastest way to achieve the deepest reductions within businesses and it also often delivers added benefits at the project site, such as employment opportunities, community development programmes and training and education.
- For a carbon offset to be credible it must meet essential quality criteria, including proof that it is additional (the reduction in emissions would not have occurred without the carbon finance), that it will be retired from the carbon market so it cannot be double counted, and that it addresses issues such as permanence (it delivers the reductions it stated) and leakage (the emission reduction in one area doesn't cause an increase in emissions somewhere else)

Example:

- Business A1 is unable to reduce 100 tonnes of its CO_2 emissions in the short term.
- There is a project somewhere else in the world which could save 100 tonnes easily, but they need a cash injection.
- For example, a community in India could swap from carbon intensive kerosene as an energy source to solar panels – but they can't afford the solar panels.
- Through the purchase of carbon offsets, you provide the financial assistance to subsidise the cost of getting solar panels onto housing, and through that means you have enabled a saving of 100 tonnes of CO_2 .
- Business A1 has therefore reduced global net CO_2 emissions by 100 tonnes.
- The added benefit is that Business A1 has helped facilitate a step change in local technology in a developing market.

21.5. CARBON TAX:

- Carbon tax is the potential alternative to the 'cap and trade' method currently used by the protocol.
- This tax is based on the amount of carbon contained in a fuel such as coal, etc.
- The aim of this tax is to cause less fossil fuel use and hopefully cause an incentive to use other sources of energy.
- If the carbon tax was implemented it would be gradual and start at a low amount and increase over time to allow better industry and technology to be developed.
- Five primary reasons why a carbon tax could prove more beneficial than the 'cap and trade' system.
 1. Predictability – the tax could help predict energy prices which might also help investments in energy efficiency and alternate fuels.
 2. Implementation – a carbon tax could be put into use much quicker compared to the legalities that go along with the 'cap and trade' method.



3. Understandable – the carbon tax is simpler to understand and may therefore be embraced more by everyday people
4. Lack of Manipulation – special interest groups have less of a chance to manipulate a carbon tax because of its simplicity.
5. Rebates – like other forms of taxes, the carbon tax could be open for rebates to the public

India's Position on carbon tax:

- India will bring a WTO challenge against any "carbon taxes" that rich countries impose on Indian imports.
 - "If they impose such a tax, we will take them to the WTO dispute settlement forum," "We will deal [with this] through hard negotiations. Such barriers are not going to be WTO-compatible and we will fight it." - the minister, MoEF
- Both United States and European Union have discussed the possibility of imposing tariffs or other forms of "border carbon adjustment" on goods imported from countries with tax regulations on greenhouse gas emissions.

Do you know?

Generally, softwood tracheids are preferred over hardwood fibers for papermaking because the tracheids of conifers are longer (about 2-4 mm) than are hardwood fibers (0.5-1.5 mm).

21.6. GEO-ENGINEERING:

- Geo-engineering primarily aims at modifying and cooling Earth's environment, defeating the environmental damage and ensuing climate changes to make the planet more inhabitable. Geoengineering, at this point, is still only a theoretical Concept
- Hoisting parasols, placing mirrors in space, whitening the stratosphere with sulfate aerosols, whitewashing building roofs to reflect sunlight or flinging iron filings into the ocean to promote carbon-gulping algae are some of the modes.

Africa's Great Green Wall project

Launched in 2007, it aims to plant an arc of trees running 7,000 kilometers across Africa, from Senegal along the Atlantic all the way to Djibouti on the Gulf of Aden to stop the Sahara Desert from spreading further south.

How Geoengineering Works: 5 Big Plans to Stop Global Warming

1. Copy a Volcano

- A volcanic eruption can bellow many million tons of sulfur-dioxide gas into the atmosphere, creating a cloud that blocks some of the sun's radiation. By injecting the atmosphere with sulfur, some scientists believe they could likewise block solar radiation and potentially cool the planet.
- Those droplets are particularly good at scattering the sun's light back out into space. And because sulfur doesn't heat the stratosphere as much as other aerosols, it wouldn't work against the cooling effect. Hydrogen sulfide is an even better candidate for atmospheric seeding than sulfur dioxide.

2. Shoot Mirrors Into Space

- In order to deflect enough sunlight to bring the Earth's climate back to its pre-industrial level, geoengineers plan to launch a mirror, the size of Greenland and strategically position it between the planet and the sun.

3. Seed the Sea with Iron

- Scientist suggests iron will be the key to turn things around. Phytoplankton, which dwell near the surface, prefer iron.
- They are also adapt at pulling carbon out of the atmosphere during photosynthesis.
- When they die after about 60 days, the carbon the organisms have consumed falls to the bottom of the ocean.



- By pumping iron into the sea and stimulating phytoplankton to grow like crazy, scientist believe, global warming could be reversed.

4. Whiten the Clouds with Wind-Powered Ships

- Scientist hopes, like the volcanic eruption, the tops of clouds also reflect solar radiation. Spraying a lot of seawater into the sky by wind powered remotely activated ships to whiten the clouds and thus it will reflect solar radiation.

5. Build Fake Trees

- “artificial tree,” a scaled-down version of an earlier prototype capable of capturing a ton of carbon in the atmosphere per day.
- Panels covering the surface of the tree--which would need to be about 50 square meters--will be made of an absorbent resin that reacts with carbon dioxide in the air to form a solid.
- It can be compared to a furnace filter, capable of pulling particles out of the air.
- The panels, or “boxes,” can be removed and exposed to 113 F steam, which effectively cleans the filter.
- The chemical reaction with the steam causes the solid to release the carbon it has captured, which can then seize as liquid CO_2 .

- But pulling carbon dioxide from the atmosphere is only half the battle--afterwards it must be sequestered, or permanently trapped.

How sequestrated CO_2 can be commercials used?

- Horticulturists need CO_2 in greenhouses for plants to use during photosynthesis,
- For dry ice production, and
- For developing new kinds of plastic and concrete that can be made with CO_2 .

Drawbacks

- Scientists have no idea whether they could shut down some of these geoengineering projects once they start.
- Geoengineering treats the symptoms of global warming, and could very well undermine efforts to address the root cause.
- people may feel as though they don't need to reduce their personal carbon emissions and companies may continue to conduct business as usual, expecting researchers to clean up the mess.
- The cost, maintenance for geoengineering projects are too high.



CHAPTER - 22



RENEWABLE ENERGY

Consumption of non-renewable sources of energy has caused more environmental damage than any other human activity. Electricity generated from fossil fuels has led to high concentrations of harmful gases in the atmosphere. This has in turn led to many environmental and health problems being faced today.

Therefore, alternative sources of energy have become very important and relevant.

Renewable energy is energy that is generated from natural resources that are continuously replenished. This includes sunlight, geothermal heat, wind, tides, water, and various forms of biomass. This energy cannot be exhausted and is constantly renewed.

They are viable source of clean limitless energy, cause less emission, and are available locally. The use of renewable energy greatly reduces all sort of pollutions vis-a-vis non-renewable energy. Most of the renewable sources of energy are fairly non-polluting and considered clean. But biomass though a renewable source, is a major contributor of indoor pollution.

Electricity is the flow of energy or current and is one of the most widely used forms of energy throughout the world.

Sources

Primary source - renewable energy like solar, wind, geothermal

Renewable energy comprises of

- Solar energy - energy generated from the sun
- Hydel energy - energy derived from water
- Biomass - energy from firewood, animal dung, biodegradable waste and crop residues, when it is burnt.
- Geothermal energy- energy from hot dry rocks, magma, hot water springs, natural geysers, etc.
- Ocean thermal - energy from waves and also from tidal waves.
- Co-generation - producing two forms of energy from one fuel.
- Fuel cells are also being used as cleaner energy source.

Secondary source - non-renewable energy generated through the conversion of coal, oil, natural gas etc.

The Government has up-scaled the target of renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power. India has also aimed a target of 500GW non fossil fuel based energy by 2030.

As of 2023 the renewable capacity in India stands at 179.32 GW which includes 67 GW of solar energy and 42 GW of wind energy. (July 2023).

India's installed renewable energy capacity has increased by over five and a half times which is about 43 per cent of the country's total capacity (as on July 2023).



22.1 SOLAR ENERGY

India is one of the few countries naturally blessed with long days and plenty of sunshine.

There are two ways we can produce electricity from the sun light:

- Photovoltaic Electricity – uses photovoltaic cells that absorb the direct sunlight to generate electricity
- Solar-Thermal Electricity – uses a solar collector that has a mirrored surface which reflects the sunlight onto a receiver that heats up a liquid. This heated up liquid is used to make steam that produces electricity.

22.1.1 Photovoltaic Electricity

Solar panels are attached to an aluminium mounting system. Photovoltaic (PV) cells are made up of at least 2 semi-conductor layers - a positive charge, and a negative charge. As a PV cell is exposed to sunlight, photons are reflected, pass right through, or absorbed by the solar cell. When enough photons are absorbed by the negative layer of the photovoltaic cell, electrons are freed from the negative semiconductor material. These freed electrons migrate to the positive layer creating a voltage differential. When the two layers are connected to an external load, the electrons flow through the circuit creating electricity. The power generated - Direct Current (DC) is converted to Alternate Current (AC) with the use of inverters.

22.1.2 Concentrated Solar Power (CSP) or solar thermal technology

It utilises focused sunlight and convert it into high-temperature heat. That heat is then channelled through a conventional generator to produce electricity.

Solar collectors capture and concentrate sunlight to heat a fluid which in turn generates electricity. There are several variations in the shape of the collectors. The most commonly used are the parabolic troughs. Parabolic trough power plants use a curved, mirrored trough which reflects the direct solar radiation onto a glass tube containing a fluid and the fluid gets heated owing to the concentrated solar radiation and the hot steam generated is used to rotate the turbine to

generate electricity. Commonly used fluids are synthetic oil, molten salt and pressurised steam.

The power generated - Direct Current (DC) is converted to Alternate Current (AC) with the use of inverters.

22.1.3 Potential of solar energy in India

- India has the potential to generate 35 MW/km² using solar photovoltaic and solar thermal energy.
- Solar energy of about 5,000 trillion kWh per year is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Hence both technology routes (solar thermal and solar photovoltaic) for conversion of solar radiation into heat and electricity can effectively be harnessed providing huge scalability for solar power in India.
- The states with very high solar radiation are Rajasthan, northern Gujarat and parts of Ladakh region, Andhra Pradesh, Maharashtra and Madhya Pradesh.

22.1.4 Installed capacity – India

The installed solar energy capacity has increased by over 15 times, and stands at 61.97 GW in 2022.

A major initiative called 'The National Solar Mission' was formulated by Government of India and its state governments.

One of the main features of the Mission is to make India a global leader in solar energy and the mission envisages an installed solar generation capacity of 100 GW (revised target) by 2022.

22.1.5 International Solar Alliance

International Solar Alliance (ISA) is launched at the CoP21 Climate Conference in Paris on 30th November as a special platform for mutual cooperation among 121 solar resource rich countries lying fully or partially between Tropic of Cancer and Tropic of Capricorn.

The alliance is dedicated to address special energy needs of ISA member countries.

International Agency for Solar Policy and Application (IASPA) will be the formal name of International Solar



Alliance. The ISA secretariat will be set up in National Institute of Solar Energy, Gurgaon.

So far 94 countries ratified ISA.

Objectives

1. to force down prices by driving demand;
2. to bring standardization in solar technologies
3. to foster research and development.

Prime Minister coined the new term "Surya Putra" for all the nations which fall between Tropic of Cancer and Tropic of Capricorn, and which have been invited to join the alliance. The other term used for these countries is "Sunshine Countries".

IESS 2047 stands for India Energy Security Scenarios 2047 calculator which has been launched by India to explore the potential of future energy scenarios for India.

2.1.6. OSOWOG initiative

The Green Grids Initiative, known as One Sun, One World, One Grid (GGI - OSOWOG), represents a collaborative effort involving the International Solar Alliance (ISA), India, France, and the United Kingdom. Its core objective is the establishment of a Global Green Energy Grid, with a primary emphasis on harnessing solar and wind energy sources.

The One Sun One World One Grid (OSOWOG) initiative seeks to implement a transnational electricity grid capable of providing power to regions across the globe.

22.2. LUMINESCENT SOLAR CONCENTRATORS

A luminescent solar concentrator (LSC) is a device that uses a thin sheet of material to trap solar radiation over a large area, before directing the energy (through luminescent emission) to cells mounted on the thin edges of the material layer.

The thin sheet of material typically consists of a polymer (such as polymethylmethacrylate (PMMA)), doped with luminescent species such as organic dyes, quantum dots or rare earth complexes.

22.2.1. What is the need for LSCs?

- The main motivation for implementing LSCs is to replace a large area of expensive solar cells in a standard flat-plate PV panel, with a cheaper alternative. Therefore there is both a reduction in both the cost of the module (£/W) and the solar power produced (£/kWh).
- A key advantage of over typical concentrating systems is that LSCs can collect both direct and diffuse solar radiation. Therefore tracking of the sun is not required.
- LSCs are excellent candidates for building integrated photovoltaics (BIPV) and for the cloudier northern climates.

Ideal LSC

- A broad absorption range to utilize the solar spectrum efficiently.
- 100% emission of light from the absorbing luminescent species.
- A large shift between the absorption and emission spectra to reduce absorption losses.
- Long term stability.

Challenges for LSC

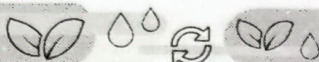
- The development of LSCs aims to create a working structure that performs close to the theoretical maximum efficiency.

22.2.2. International Renewable Energy Agency (IRENA)

IRENA has 167 member nations with Headquarters in Abu Dhabi.

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy.

IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy,



including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

22.3 WIND ENERGY

Wind energy is the kinetic energy associated with the movement of atmospheric air. Wind turbines transform the energy in the wind into mechanical power, further converting to electric power to generate electricity. Five nations – China, Germany, USA, Spain and India – account for 80% of the world's installed wind energy capacity.

22.3.1 Wind farm

A wind farm is a group of wind turbines in the same location used for production of electricity. A wind farm can be located onshore and offshore.

- **Onshore wind farms:** operate on land, where the wind tends to be the strongest. The turbines of a Onshore wind farms are less expensive and easier to set up, maintain and operate than offshore turbines.
- **Offshore wind farms:** Construction of wind farms in large bodies of water to generate electricity. Offshore wind farms are more expensive than onshore wind farms of the same nominal power.

22.3.2 Working of wind turbines

Wind turbines convert the kinetic energy in the wind into mechanical energy. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity. Most turbines have three aerodynamically designed blades. The energy in the wind turns two or three propeller-like blades around a rotor that is connected to the main shaft, which spins a generator to create electricity. Wind turbines are mounted on a tower to capture the most energy. At 100 feet (30 meters) or more above ground, they can take advantage of faster and less turbulent wind.

Three main variables determine how much electricity a turbine can produce:

1. **Wind speed-** stronger winds produce more energy. Wind turbine generates energy at a speed of 4-25 metres per second
2. **Blade radius-** the larger the radius of blades, the more the energy produced. Doubling the blade radius can result in four times more power.
3. **Air density-** Heavier air exerts more lift on a rotor. Air density is a function of altitude, temperature and pressure. High altitude locations have low air pressure and lighter air so they are less productive turbine locations. The dense heavy air near sea level drives rotors faster and thus relatively more effectively.

22.3.3 Two types of wind turbines

- 1) Horizontal-axis design has two or three blades that spin upwind of the tower. A horizontal axis machine has its blades rotating on an axis parallel to the ground.
- 2) Vertical-axis turbines has vertical blades that rotate in and out of the wind. The vertical axis turbine has its blades rotating on an axis perpendicular to the ground. This drag-type turbine turns relatively slowly but yields a high torque. It is useful for grinding grain, pumping water and many other tasks, but its slow rotational speeds are not optimal for generating electricity. Vertical-axis turbines do not take advantage of the higher wind speeds at higher elevations (100 feet and so) above the ground vis-a-vis horizontal axis turbines.

22.3.4 Potential of wind energy in India

The National Institute of Wind Energy (NIWE) has recently launched Wind Energy Resource Map of India at 100 meter above ground level (AGL) on online Geographic Information System platform.

The wind energy potential in the country at 100 m AGL is over 302 GW, 695.5 GW at 120 m AGL. Gujarat has the maximum potential followed by Karnataka, Maharashtra, Andra Pradesh according to the resource map.

Wind energy target

- 60000 MW (60 GW) by 2022
- 200000 MW (200 GW) by 2022



22.3.5 Capacity installed

The country has the total installed capacity of 42 GW (as on July 2023).

Highest Producing States	Up to 2019	2021-22
Tamil Nadu	8968.89	9000
Kerala	4299.5	7855
Andhra Pradesh	4794.18	4789
Karnataka	4694.9	4779

22.3.6. National Offshore Wind Energy Policy, 2015:

Under this Policy, the Ministry of New & Renewable Energy (MNRE) has been authorized as the Nodal Ministry for use of offshore areas within the Exclusive Economic Zone (EEZ) of the country and the National Institute of Wind Energy (NIWE) has been authorized as the Nodal Agency for development of offshore wind energy in the country and to carry out allocation of offshore wind energy blocks, coordination and allied functions with related ministries and agencies.

It would pave the way for offshore wind energy development including, setting up of offshore wind power projects and research and development activities, in waters, in or adjacent to the country, up to the seaward distance of 200 Nautical Miles (EEZ of the country) from the base line.

The policy will provide a level playing field to all investors/beneficiaries, domestic and international.

National Wind Energy Mission (Proposed):

Initiated the process of establishing National Wind Energy Mission.

The setting up of a Mission would help in

- achieving the targets of 12th Plan and energy generation from renewable energy as set under NAPCC, and
- addressing the issues and challenges which the wind sector is faced with, such as precise resource assessment, effective grid integration, improvement in technology and manufacturing base, to maintain its comparative advantage in the wind sector.

22.4. HYDRO POWER

Hydraulic power can be captured when water flows downward from a higher level to a lower level which is then used to turn the turbine, thereby converting the kinetic energy of water into mechanical energy to drive the generator.

Hydro power is cheapest, and cleanest source of energy but there are many environmental and social issues associated with big dams as seen in projects like Tehri, Narmada, etc. Small hydro power are free from these problems

22.4.1 Types of hydro power stations

There are three types of hydropower facilities: impoundment, diversion, and pumped storage. Some hydropower plants use dams and some do not.

(1) Impoundment

The most common type of hydroelectric power plant is an impoundment facility. An impoundment facility, typically a large hydropower system, uses a dam to store river water in a reservoir. Water released from the reservoir flows through a turbine, spinning it, which in turn activates a generator to produce electricity.

(2) Diversion

A diversion, sometimes called run-of-river facility, channels a portion of a river through a canal or penstock and then to flow through a turbine, spinning it, which in turn activates a generator to produce electricity. It may not require the use of a dam.

(3) Pumped storage

It works like a battery, storing the electricity generated by other power sources like solar, wind, and nuclear for later use. When the demand for electricity is low, a pumped storage facility stores energy by pumping water from a lower reservoir to an upper reservoir. During periods of high electrical demand, the water is released back to the lower reservoir and turns a turbine, generating electricity.



22.4.2 Small Hydro Power (SHP)

Small hydro is defined as any hydro power project which has an installed capacity of less than 25 MW. It is in most cases run-of-river, where a dam or barrage is quite small, usually just a weir with little or no water is stored. Therefore run-of-river installations do not have the same kind of adverse effect on the local environment as large-scale hydro projects. Small hydropower plants can serve the energy needs of remote rural areas independently.

India and China are the major players of the SHP sector, holding the highest number of installed projects.

22.4.3 Small Hydro Potential in India

- An estimated 7,133 sites of small hydro have been identified with a potential of around 21,100 MW.
- River based projects in the Himalayan states and irrigation canals in other states have massive potential for development of Small Hydro Projects.
- The Ministry of New and Renewable Energy is encouraging development of Small Hydro Projects in both the public and private sector and aims to exploit at least 50% of the current potential in the next 10 years.

22.4.4 Installed capacity

The cumulative installed capacity of Small Hydro Projects amount to 4.9 GW.

22.5 OCEAN THERMAL ENERGY

Large amounts of solar energy is stored in the oceans and seas. On an average, the 60 million square kilometre of the tropical seas absorb solar radiation equivalent to the heat content of 245 billion barrels of oil.

The process of harnessing this energy is called OTEC (ocean thermal energy conversion). It uses the temperature differences between the surface of the ocean and the depths of about 1000m to operate a heat engine, which produces electric power

Wave energy

Waves result from the interaction of the wind with the surface of the sea and represent a transfer of energy from the wind to the sea.

The first wave energy, project with a capacity of 150MW, has been set up at Vizhinjam near Trivandrum.

Tidal energy

Energy can be extracted from tides by creating a reservoir or basin behind a barrage and then passing tidal waters through turbines in the barrage to generate electricity.

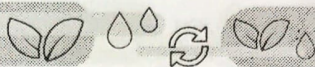
A major tidal wave power project costing of Rs.5000 crores, is proposed to be set up in the Hantahl Creek in the Gulf of Kutch in Gujarat.

22.6 BIOMASS

Biomass is a renewable energy resource derived from the carbonaceous waste of various human and natural activities. It is derived from numerous sources, including the by-products from the timber industry, agricultural crops, grassy and woody plants, residues from agriculture or forestry, oil-rich algae, and the organic component of municipal and industrial wastes. Biomass is a good substitute for the conventional fossil fuels for heating and energy generation purposes.

Burning biomass releases about the same amount of carbon dioxide as burning fossil fuels. However, fossil fuels release carbon dioxide captured by photosynthesis over its formative years. Biomass, on the other hand, releases carbon dioxide that is largely balanced by the carbon dioxide captured in its own growth (depending how much energy was used to grow, harvest, and process the fuel). Hence, Biomass does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon in growing as it releases when consumed as a fuel.

Chemical processes like gasification, combustion and pyrolysis convert biomass to useful products, combustion being the most common of them. Each of the technologies mentioned produces a major calorific end product and a mixture of by-products. The processing method is selected on the basis of nature



and origin of feed stocks, their physiochemical state and application spectrum of fuel products derived from it.

Anaerobic Digestion/Biomethanation

Biomethanation, or methanogenesis, is a scientific process whereby anaerobic microorganisms in an anaerobic environment decompose biodegradable matter producing methane-rich biogas and effluent. The three functions that take place sequentially are hydrolysis, acidogenesis and methanogenesis.

Combustion/Incineration

In this process, waste is directly burned in the presence of excess air (oxygen) at high temperatures (about 800°C), liberating heat energy, inert gases and ash. Combustion results in transfer of 65–80% of heat content of the organic matter to hot air, steam and hot water. The steam generated, in turn, can be used in steam turbines to generate power.

Pyrolysis/Gasification

Pyrolysis is a process of chemical decomposition of organic matter brought about by heat. In this process, the organic material is heated in the absence of air until the molecules thermally break down to become a gas comprising smaller molecules (known collectively as syngas).

Gasification can also take place as a result of partial combustion of organic matter in the presence of a restricted quantity of oxygen or air. The gas so produced is known as producer gas. The gases produced by pyrolysis mainly comprise carbon monoxide (25%), hydrogen and hydrocarbons (15%), and carbon dioxide and nitrogen (60%). The next step is to 'clean' the syngas or producer gas. Thereafter, the gas is burned in internal combustion (IC) engine generator sets or turbines to produce electricity.

22.7 COGENERATION

Co-generation is producing two forms of energy from one fuel. One of the forms of energy must always be heat and the other may be electricity or mechanical

energy. In a conventional power plant, fuel is burnt in a boiler to generate high-pressure steam. This steam is used to drive a turbine, which in turn drives an alternator through a steam turbine to produce electric power. The exhaust steam is generally condensed to water which goes back to the boiler.

As the low-pressure steam has a large quantum of heat which is lost in the process of condensing, the efficiency of conventional power plants is only around 35%. In a cogeneration plant, the low-pressure exhaust steam coming out of the turbine is not condensed, but used for heating purposes in factories or houses and thus very high efficiency levels, in the range of 75%–90%, can be reached.

Since co-generation can meet both power and heat needs, it has other advantages as well in the form of significant cost savings for the plant and reduction in emissions of pollutants due to reduced fuel consumption.

Even at conservative estimates, the potential of power generation from co-generation in India is more than 20,000 MW. Since India is the largest producer of sugar in the world, bagasse-based cogeneration is being promoted. The potential for cogeneration thus lies in facilities with joint requirement of heat and electricity, primarily sugar and rice mills, distilleries, petrochemical sector and industries such as fertilizers, steel, chemical, cement, pulp and paper, and aluminium.

Potential in India

- Biomass energy is one of the most important sources of energy forming 32% of the total primary energy usage in the country with more than 70% of the Indian population dependent on it for its energy needs.
- The current availability of biomass is estimated at about 750 million tonnes annually translating to a potential of around 28 GW.
- In addition, about 5000 MW additional power could be generated through bagasse based cogeneration in the country's 550 Sugar mills
- It attracts over Rs 600 crore in investments annually creating rural employment of more than



10 million man days whilst generating more than 5000 million units of electricity.

Installed capacity in India

- As on 31 October, 2022, a total capacity of 10205.61 MW has been installed in Biomass Power and Cogeneration Sector. Installed Capacity of Biomass IPP - 1836 MW, Bagasse Cogeneration - 7562 MW, and Non-Bagasse Cogeneration - 772 MW. Also, 30 biomass power projects aggregating about 350 MW are under different stages of implementation.
- Maharashtra, Karnataka, Uttar Pradesh, Andhra Pradesh and Tamil Nadu are the leading states in the implementation of bagasse cogeneration projects.
- In the biomass power projects, Chhattisgarh, Madhya Pradesh, Gujarat, Rajasthan and Tamil Nadu have taken leadership position.
- The Government plans to meet 20% of the countries diesel requirements by 2020 using biodiesel. Potential sources of biodiesel production have been identified in wild plants such as jatropha curcas, neem, mahua, karanj, Simarouba (exotic tree) etc.
- Several incentive schemes have been introduced to rehabilitate waste lands through the cultivation of Jatropha.
- Central Finance Assistance (CFA) is provided by the Ministry of New and Renewable Energy (MNRE) in the form of capital subsidy and financial incentives to biomass energy projects in India.

22.8 WASTE TO ENERGY

In today's era, there are increasing quantities of waste due to urbanization, industrialization and changes in life patterns which are harmful to the environment. In the recent past, development of technology has helped to reduce the amount of waste for its safe disposal and to generate electricity from it.

Waste-to-energy has the potential to divert waste from landfills and generate clean power without the emission of harmful greenhouse gas. This significantly

reduces the volume of waste that needs to be disposed of and can generate power. Pyrolysis and gasification are emerging technologies apart from the common incineration and biomethanation.

22.8.1 Potential of waste-to-energy

- There is an estimated potential of about 502 MW from all sewage and about 1460 MW from Municipal Solid Waste (MSW) in India totaling around 5690 MW of power.
- There is current potential to recover 1,300 MW of power from industrial wastes, which is projected to increase to 2,000 MW by 2017.
- The total installed capacity of grid interactive power from Waste to energy is 99.08 MW of grid power and about 115.07 MW of off-grid power.
- MNRE is actively promoting the generation of energy from waste by providing incentives and subsidies on projects

22.8.2. Major Constraints Faced by the Indian Waste to Energy Sector

- **Choice of technology** - Waste-to-Energy is still a new concept in India. Most of the proven and commercial technologies in respect of urban wastes are required to be imported;
- **High costs** - The costs of the projects especially based on biomethanation technology are high as critical equipment for a project is required to be imported.
- **Improper segregation** - India lacks a source separated waste stream, owing to the low level of compliance of Municipal Solid Waste (MSW) Rules 2000 by the Municipal Corporations/ Urban Local Bodies. The organic waste is mixed with the other types of waste. Hence the operations of the waste to energy techniques are hindered and a lack of smoothness causes the attempts to be short lived.
- **Lack of policy support** - Lack of conducive policy guidelines from State Governments in respect of allotment of land, supply of garbage and power purchase / evacuation facilities.



22.9 GEOTHERMAL ENERGY

Geothermal generation refers to harnessing of the geothermal energy or the vast reservoir of heat stored in the earth's inner core. Below the earth's crust, there is a layer of hot and molten rock called 'magma'. Heat is continually produced there, mostly from the decay of naturally radioactive materials such as uranium and potassium.

How is it captured

Geothermal systems can be found in regions with a normal or slightly above normal geothermal gradient (gradual change in temperature is known as the geothermal gradient, which expresses the increase in temperature with depth in the earth's crust. The average geothermal gradient is about 2.5-3 °C/100 m.) and especially in regions around plate margins where the geothermal gradients may be significantly higher than the average value.

The most common current way of capturing the energy from geothermal sources is to tap into naturally occurring "hydrothermal convection" systems where cooler water seeps into the earth's crust, is heated up and then rises to the surface. When heated water is forced to the surface, it is a relatively easy to capture that steam and use it to drive electric generators.

Potential in India

India has a potential for producing around 10,600 MW of power from geothermal resources. Although India was among the earliest countries to begin geothermal projects since the 1970's, at present there are no operational geothermal plants in India. 340 hot springs were identified across India. These have been grouped together and termed as different geothermal provinces based on their occurrence in specific geotectonic regions, geological and structural regions such as occurrence in orogenic belt regions, structural grabens, deep fault zones, active volcanic regions etc.

Orogenic regions:

1. Himalayan geothermal province
2. Naga-Lushai geothermal province

3. Andaman-Nicobar Islands geothermal province

Non-orogenic regions:

1. Cambay graben,
2. Son-Narmada-Tapigraben,
3. West coast,
4. Damodar valley,
5. Mahanadi valley,
22. Godavari valley etc

Potential Sites:

1. Puga Valley (J&K)
2. Tattapani (Chhattisgarh)
3. Godavari Basin Manikaran (Himachal Pradesh)
4. Bakreshwar (West Bengal)
5. Tuwa (Gujarat)
22. Unai (Maharashtra)
7. Jalgaon (Maharashtra)

Recent Developments:

In 2013, India's first geothermal power plant was announced to be set up in Chhattisgarh. The plant would be set up at Tattapani in the Balrampur district.

Satellites like the IRS-1 have played an important role, through infrared photographs, in locating geothermal areas.

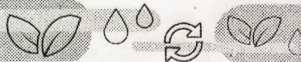
Challenges

High generation costs

Most costs relating to geothermal power plants are incurred due to resource exploration and plant construction.

Drilling costs

Although the cost of generating geothermal electricity has decreased by 25 percent during the last two decades, exploration and drilling remain expensive and risky. It is because rocks in geothermal areas are extremely hard and hot, developers must frequently replace drilling equipment.



Transmission barrier

Geothermal power plants must be located near specific areas near a reservoir because it is not practical to transport steam or hot water over distances greater than two miles. Since many of the best geothermal resources are located in rural areas, developers may be limited by their ability to supply electricity to the grid. New power lines are expensive to construct and difficult to site. Many existing transmission lines are operating near capacity and may not be able to transmit electricity without significant upgrades. Consequently, any significant increase in the number of geothermal power plants will be limited by the plants ability to connect, upgrade or build new lines to access the power grid and whether the grid is able to deliver additional power to the market.

Accessibility

Some areas may have sufficient hot rocks to supply hot water to a power station, but many of these areas are located in harsh areas or high up in mountains. This curbs the accessibility of geothermal resources adding on to the costs of development.

Execution challenges

Harmful radioactive gases can escape from deep within the earth through the holes drilled by the constructors. The plant must be able to contain any leaked gases and ensure safe disposal of the same.

22.10 FUEL CELLS

Fuel cells are electrochemical devices that convert the chemical energy of a fuel directly and very efficiently into electricity (DC) and heat, thus doing away with combustion. The most suitable fuel for such cells is hydrogen or a mixture of compounds containing hydrogen. A fuel cell consists of an electrolyte sandwiched between two electrodes. Oxygen passes over one electrode and hydrogen over the other, and they react electrochemically to generate electricity, water, and heat.

Fuel cells for automobile transport

Compared to vehicles powered by the internal combustion engine, fuel-cell powered vehicles have very high energy conversion efficiency, and near-zero pollution, CO₂ and water vapour being the only emissions. Fuel-cell-powered EV's (electric vehicles) score over battery operated EV's in terms of increased efficiency and easier and faster refuelling.

In India, diesel run buses are a major means of transport and these emit significant quantities of SPM and SO₂. Thus, fuel-cell powered buses and electric vehicles could be introduced with relative ease to dramatically reduce urban air pollution and to make a positive impact on urban air quality.

Fuel cells for power generation

Conventional large-scale power plants use non-renewable fuels with significant adverse ecological and environmental impacts. Fuel cell systems are excellent candidates for small-scale decentralized power generation.

Fuel cells can supply combined heat and power to commercial buildings, hospitals, airports and military installation at remote locations. Fuel cells have efficiency levels up to 55% as compared to 35% of conventional power plants. The emissions are significantly lower (CO₂ and water vapour being the only emissions). Fuel cell systems are modular (i.e. additional capacity can be added whenever required with relative ease) and can be set up wherever power is required.

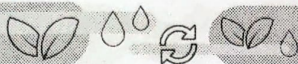
Constraint

High initial cost is the biggest hurdle in the widespread commercialization of fuel cells.

REN21

REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors from:

- Governments



- International organisations
- Industry associations
- Science and academia as well as civil society

To facilitate knowledge exchange, policy development and joint action towards a rapid global transition to renewable energy. REN21 promotes renewable energy to meet the needs of both industrialized and developing countries that are driven by climate change, energy security, development and poverty alleviation.

Do you know?

Hydrogen Energy Mission 2021-22 aim is to develop India into a global hub for manufacturing of hydrogen and fuel cells technologies across the value chain.

It is an international non-profit association and committed to the following objectives:

- Providing policy-relevant information and research-based analysis on renewable energy to decision makers, multipliers and the public to catalyse policy change
- Offering a platform for interconnection between multi-stakeholder actors working in the renewable energy field worldwide and identifying barriers as well as working to bridge existing gaps to increase the large-scale deployment of renewable energy worldwide.

Conclusion

Efficient use of renewable energy would reduce our dependence on non-renewable sources of energy, make us energy self-sufficient and make our environment cleaner. As more green power sources are developed - displacing conventional generation - the overall environmental impacts associated with electricity generation will be significantly reduced.

22.10.1. National Green Hydrogen Mission

India has set its sight on becoming energy independent by 2047 and achieving Net Zero by 2070. To achieve this target, increasing renewable energy use across all economic spheres is central to India's Energy Transition. Green Hydrogen is considered a promising alternative for enabling this transition. Hydrogen can be utilized for long-duration storage of renewable energy, replacement of fossil fuels in industry, clean transportation, and potentially also for decentralized power generation, aviation, and marine transport.

Objectives

- Making India a leading producer and supplier of Green Hydrogen in the world
- Creation of export opportunities for Green Hydrogen and its derivatives
- Reduction in dependence on imported fossil fuels and feedstock
- Development of indigenous manufacturing capabilities
- Attracting investment and business opportunities for the industry
- Creating opportunities for employment and economic development
- Supporting R&D projects

Mission Outcomes

The mission outcomes projected by 2030 are:

- Development of green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country
- Over Rs. Eight lakh crore in total investments
- Creation of over Six lakh jobs
- Cumulative reduction in fossil fuel imports over Rs. One lakh crore



- Abatement of nearly 50 MMT of annual greenhouse gas emissions

22.10.2. Types Of Hydrogen Based On Extraction Methods

Depending on the nature of the method of its extraction, hydrogen is categorised into three categories, namely, Grey, Blue and Green.

- **Grey Hydrogen:** It is produced via coal or lignite gasification (black or brown), or via a process called steam methane reformation (SMR) of natural gas or methane (grey). These tend to be mostly carbon-intensive processes.
- **Blue Hydrogen:** It is produced via natural gas or coal gasification combined with carbon capture

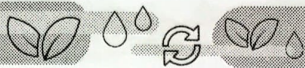
storage (CCS) or carbon capture use (CCU) technologies to reduce carbon emissions.

- **Green Hydrogen:** It is produced using electrolysis of water with electricity generated by renewable energy. The carbon intensity ultimately depends on the carbon neutrality of the source of electricity (i.e., the more renewable energy there is in the electricity fuel mix, the “greener” the hydrogen produced).

Do you know?

The International Solar Alliance (ISA) is all set to usher in the introduction of solar energy technology to drive biodiversity conservation and livelihood activities at Chilika.





CHAPTER - 23



INDIA AND CLIMATE CHANGE

23.1. INDIA'S POSITION ON CLIMATE CHANGE

- India's share of world population is 17% but the country's share in cumulative historical emissions is just 3.37% and even the current annual emissions are only 7% of the global emissions and the per capita emissions are about a third of the global average.
- India emitted 3.9 billion metric tonnes of CO₂ equivalent greenhouse gases in 2021.
- Energy sector was the prime contributor to emissions and with 70% of total emissions in 2021. Energy sector includes - electricity production, fuel combustion in industries, transport and fugitive emissions.
- Industrial processes and product use contributed 8%; agriculture and waste sectors contributed 18% and 3% respectively to the national GHG inventory.
- About 15% of emissions were offset by carbon sink action of forests and croplands, considering which the national GHG emissions are arrived at a total of 3.9 billion metric tonnes of CO₂ equivalent.
- India's per capita GHG emission in 2010 was 1.91 metric tCO₂ equivalent, which is less than one-third of the world's per capita emissions and far below than many developed and developing countries.

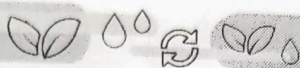
- A reduction of emission intensity of GDP by about 24% between 2005 and 2016 has been achieved against our voluntary pledge to reduce the emission intensity of its GDP by 45 per cent by 2030, compared with the 2005 level.
- India will continue to be a low-carbon economy (World Bank study).
- India's primary focus is on "adaptation", with specific focus for "mitigation".
- India has already unveiled a comprehensive National Action Plan on Climate Change whose activities are in the public domain.
- India advocates collaborative research in future low-carbon technology and access to intellectual property rights (IPRs) as global public goods.

23.2. OBSERVED CLIMATE AND WEATHER CHANGES IN INDIA

- India's National Communication (NATCOM) to UNFCCC has consolidated some of the observed changes in climate parameters in India. No firm link between the documented changes described below and warming due to anthropogenic climate change has yet been established.

23.2.1. Surface Temperature

- At the national level, increase of -0.4°C has been observed in surface air temperatures over the past century. A warming trend has been observed along the west coast, in central India, the interior



peninsula, and north-eastern India. However, cooling trends have been observed in north-west India and parts of south India.

23.2.2. Rainfall

- While the observed monsoon rainfall at the all-India level does not show any significant trend, regional monsoon variations have been recorded.
- A trend of increasing monsoon seasonal rainfall has been found along the west coast, northern Andhra Pradesh, and north-western India (+10% to +12% of the normal over the last 100 years) while a trend of decreasing monsoon seasonal rainfall has been observed over eastern Madhya Pradesh, north-eastern India, and some parts of Gujarat and Kerala (-6% to -8% of the normal over the last 100 years).

23.2.3. Extreme Weather Events

- Instrument records over the past 130 years do not indicate any marked long-term trend in the frequencies of large-scale droughts and floods. Trends are however observed in multi-decadal periods of more frequent droughts, followed by less severe droughts.
- There has been an overall increasing trend in severe storm incidence along the coast at the rate of 0.011 events per year. While the states of West Bengal and Gujarat have reported increasing trends, a decline has been observed in Orissa.

23.2.4. Rise in Sea Level

- The records of coastal tide gauges in the north Indian Ocean for more than 40 years, reports that sea level rise was between 1.06-1.75 mm per year. These rates are consistent with 1-2 mm per year global sea level rise estimates of IPCC.

23.2.5. Impacts on Himalayan Glaciers

- The Himalayas possess one of the largest resources of snow and ice and its glaciers form a source of water for the perennial rivers such as the Indus, the Ganga, and the Brahmaputra.

- Glacial melt may impact their long-term lean-season flows, with adverse impacts on the economy in terms of water availability and hydropower generation.
- The available monitoring data on Himalayan glaciers indicates that while recession of some glaciers has occurred in some Himalayan regions in recent years, the trend is not consistent across the entire mountain chain. It is accordingly, too early to establish long-term trends, or their causation, in respect of which there are several hypotheses.

23.3. CURRENT ACTIONS ADAPTATION AND MITIGATION

- Adaptation, in the context of climate change, comprises the measures taken to minimize the adverse impacts of climate change, e.g. relocating the communities living close to the sea shore, for instance, to cope with the rising sea level or switching to crops that can withstand higher temperatures.
- Mitigation comprises measures to reduce the emissions of greenhouse gases that cause climate change in the first place, e.g. by switching to renewable sources of energy such as solar energy or wind energy, or nuclear energy instead of burning fossil fuel in thermal power stations.
- Current Indian government expenditure on adaptation to climate variability, exceeds 2.6% of the GDP, with agriculture, water resources, health and sanitation, forests, coastal-zone infrastructure and extreme weather events, being specific areas of concern.

23.3.1. Agriculture

- Two risk-financing programmes support adaptation to climate impacts. The Crop Insurance Scheme supports the insurance of farmers against climate risks, and the Credit Support Mechanism facilitates the extension of credit to farmers, especially for crop failure due to climate variability.



23.3.2. Crop Improvement

- The present programmes address measures such as development of arid-land crops and pest management, as well as capacity building of extension workers and NGOs to support better vulnerability reducing practices.

23.3.3. Drought Proofing

- The current programmes seek to minimize the adverse effects of drought on production of crops and livestock, and on productivity of land, water and human resources, so as to ultimately lead to drought proofing of the affected areas.
- They also aim to promote overall economic development and improve the socio-economic conditions of the resource poor and disadvantaged sections inhabiting the programme areas.

23.3.4. Forestry

India has a strong and rapidly growing afforestation programme. The afforestation process was accelerated by the enactment of the Forest Conservation Act of 1980, which aimed at stopping the clearing and degradation of forests through a strict, centralized control of the rights to use forest land and mandatory requirements of compensatory afforestation in case of any diversion of forest land for any non-forestry purpose.

- In addition an aggressive afforestation and sustainable forest management programme resulted in annual reforestation of 1.78 mha during 1985-1997, and is currently 1.1 mha annually. Due to this, the carbon stocks in Indian forests have increased over the last 20 years (during 1986 to 2005) to 9 -10 gigatons of carbon (GtC).

23.3.5. Water

- The National Water Policy stresses that non-conventional methods for utilization of water,

including inter-basin transfers, artificial recharge of groundwater, and desalination of brackish or sea water, as well as traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting, should be practised to increase the utilizable water resources. Many states now have mandatory water harvesting programmes in several cities.

23.3.6. Coastal Regions

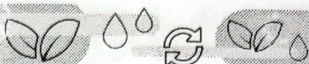
- In coastal regions, restrictions have been imposed in the area between 200m and 500m of the HTL (high tide line) while special restrictions have been imposed in the area up to 200m to protect the sensitive coastal ecosystems and prevent their exploitation.
- This, simultaneously, addresses the concerns of the coastal population and their livelihood. Some specific measures taken in this regard include construction of coastal protection infrastructure and cyclone shelters, as well as plantation of coastal forests and mangroves.

23.3.7. Health

- The prime objective present of health programmes is the surveillance and control of vector borne diseases such as Malaria, Kala-azar, Japanese Encephalitis, Filariasis and Dengue. Programmes also provide for emergency medical relief in the case of natural calamities, and to train and develop human resources for these tasks.

23.3.8. Disaster Management

- The National Disaster Management programme provides grants-in-aid to victims of weather related disasters, and manages disaster relief operations. It also supports proactive disaster prevention programmes, including dissemination of information and training of disaster-management staff.



23.4. INDIA'S NATIONAL ACTION PLAN ON CLIMATE CHANGE

In dealing with the challenge of climate change we must act on several fronts in a focused manner simultaneously. The National Action Plan hinges on the development and use of new technologies. The implementation of the Plan would be through appropriate institutional mechanisms suited for effective delivery of each individual Mission's objectives and include public private partnerships and civil society action. The focus will be on promoting understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.

There are Eight National Missions which form the core of the National Action Plan, representing multipronged, long-term and integrated strategies for achieving key goals in the context of climate change.

23.4.1. National Solar Mission

- The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge.

Objective

- To establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.
- The Mission will adopt a 3-phase approach,
 - spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1,
 - the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and
 - the 13th Plan (2017-22) as Phase 3.
- At the end of each plan, and mid-term during the 12th and 13th Plans, there will be an evaluation of progress, review of capacity and targets for subsequent phases, based on emerging cost and technology trends, both domestic and global.
- The aim would be to protect Government from subsidy exposure in case expected cost reduction

does not materialize or is more rapid than expected.

- The first phase (up to 2013) will focus on capturing of the low hanging options in solar thermal; on promoting off-grid systems to serve populations without access to commercial energy and modest capacity addition in grid-based systems.
- In the second phase, after taking into account the experience of the initial years, capacity will be aggressively ramped up to create conditions for up scaled and competitive solar energy penetration in the country.

Mission targets

- To create an enabling policy framework for deployment of 100 MW of solar power by 2023.
- The Centre has revised cumulative targets under National Solar Mission from 20,000 MW by 2021-22 to 1,00,000 MW- a quantum jump.
- The target will principally comprise of 40 GW Rooftop and 60 GW through Large and Medium Scale Grid Connected Solar Power Projects.

23.4.2. The National Mission for Enhanced Energy Efficiency (NMEEE)

- The National Mission for Enhanced Energy Efficiency (NMEEE), which seeks to strengthen the market for energy efficiency by creating conducive regulatory and policy regime.
- NMEEE has been envisaged to foster innovative and sustainable business models to the energy efficiency sector.
- The NMEEE seeks to create and sustain markets for energy efficiency in the entire country which will benefit the country and the consumers".

Objective

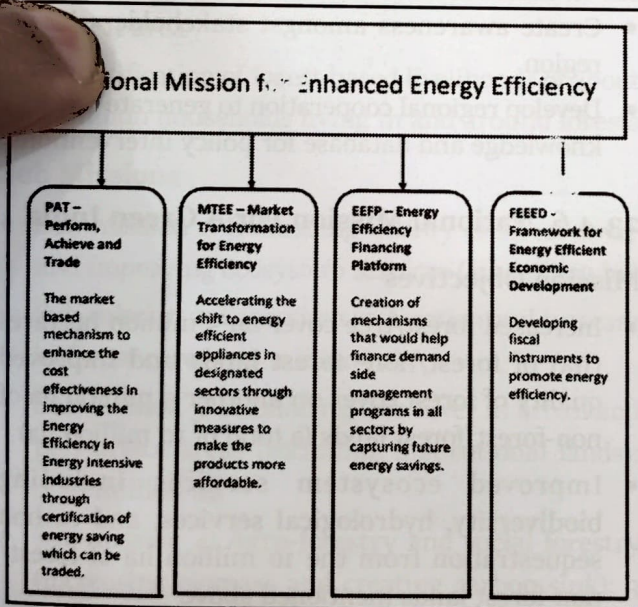
- Promoting innovative policy and regulatory regimes, financing mechanisms, and business models which not only create, but also sustain markets for energy efficiency in a transparent manner with clear deliverables to be achieved in a time bound manner.

Mission Goals

- Market-based approaches to unlock energy efficiency opportunities, estimated to be about Rs. 74,000 Crores

By 2014-15:

- Annual fuel savings in excess of 23 million toe
- Cumulative avoided electricity capacity addition of 19,000 MW
- CO₂ emission mitigation of 98 million tons per year
- Four New Initiatives to Enhance Energy Efficiency:
 - Perform Achieve and Trade
 - Market Transformation for Energy Efficiency
 - Energy Efficiency Financing Platform (EEP)
 - Framework for Energy Efficient Economic Development (FEEED)



23.4.3. National Mission on Sustainable Habitat

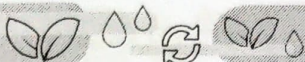
- “National Mission on Sustainable Habitat” seeks to promote sustainability of habitats through improvements in energy efficiency in buildings, urban planning, improved management of solid and liquid waste, modal shift towards public transport and conservation through appropriate changes in legal and regulatory framework.

- It also seeks to improve ability of habitats to adapt to climate change by improving resilience of infrastructure, community based disaster management and measures for improving advance warning systems for extreme weather events.
- It will broadly cover the following aspects:
 - Extension of the energy conservation building code - which addresses the design of new and large commercial buildings to optimize their energy demand;
 - Better urban planning and modal shift to public transport - make long term transport plans to facilitate the growth of medium and small cities in such a way that ensures efficient and convenient public transport;
 - Recycling of material and urban waste management - a special area of focus will be development of technology for producing power from waste.
 - The National Mission will include a major R&D programme, focusing on bio-chemical conversion, waste water use, sewage utilization and recycling options.
- Some of the key flagship missions under NMSH include:
 - Smart Cities Mission
 - Swachh Bharat Mission (Urban)
 - Pradhan Mantri Awas Yojana (Urban)
 - Atal Mission for Rejuvenation and Urban Transformation (AMRUT)
 - Heritage City Development and Augmentation Yojana (HRIDAY)
 - Green Urban Mobility Scheme (GUMS)
 - National Urban Livelihoods Mission (DAY-NULM)

23.4.4. National Water Mission (NWM)

Mission Objectives

- Ensuring integrated water resource management for conservation of water, minimization of wastage



and equitable distribution both across and within states.

- Developing a framework for optimum water use through increase in water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing, taking the National Water Policy (NWP) into consideration.
- Ensuring that a considerable share of water needs of urban areas is met through recycling of waste water.
- Meeting water requirements of coastal cities (with inadequate alternative sources of water) through the adoption of new and appropriate technologies such as low-temperature desalination technologies allowing use of ocean water.
- Revisiting NWP to ensure basin-level management strategies to deal with variability in rainfall and river flows due to climate change, including enhancement of storage both above and below ground, implementation of rainwater harvesting and establishment of equitable and efficient management structures.
- Developing new regulatory structures to optimize efficiency of existing irrigation systems, to rehabilitate run-down systems and to expand irrigation to increase storage capacity.
- Promotion of water-neutral and water-positive technologies through the design of a proper incentive structure combined with recharging of underground water sources and adoption of large-scale irrigation programme based on efficient methods of irrigation.

23.4.5. National Mission For Sustaining The Himalayan Ecosystem (NMSHE)

- The most crucial and primary objective of the mission is to develop a sustainable National capacity to continuously assess the health status of the Himalayan Ecosystem and enable policy bodies in their policy-formulation functions and assist States in the Indian Himalayan Region with their implementation of actions selected for sustainable development.

Mission Objectives

- Building Human and Institutional capacities on climate change related aspects
- Network knowledge institutions and develop a coherent database on all knowledge systems
- Detect and decouple natural and anthropogenic global environmental changes and project future trends on potential impacts
- Assess the socio-economic and ecological consequences of global environmental change and design appropriate strategies for growth in the economy of the region
- Study traditional knowledge systems for community participation in adaptation, mitigation and coping mechanisms
- Evaluate policy alternatives for regional development plans
- Create awareness amongst stakeholders in the region
- Develop regional cooperation to generate a strong knowledge and database for policy interventions

23.4.6. National Mission For A Green India

Mission Objectives

- Increased forest/tree cover on 5 million hectares (ha) of forest/non- forest lands and improved quality of forest cover on another 5 million ha of non-forest/forest lands (a total of 10 million ha)
- Improved ecosystem services including biodiversity, hydrological services, and carbon sequestration from the 10 million ha of forest/non-forest lands mentioned above
- Increased forest-based livelihood income of about 3 million households, living in and around the forests
- Enhanced annual CO₂ sequestration by 50 to 60 million tones in the year 2020

Mission Targets

- Improvement in the quality of forest cover and ecosystem services of forests /nonforests,



- (including moderately dense, open forests, degraded grassland and wetlands: 5 million ha)
- Eco-restoration/afforestation of scrub, shifting cultivation areas, cold deserts, mangroves, ravines and abandoned mining areas (2 million ha)
 - Improvement in forest and tree cover in urban/peri-urban lands (0.20 million ha)
 - Improvement in forest and tree cover on marginal agricultural lands/fallows and other non-forest land under agro-forestry/social forestry (3 million ha)
 - Management of public forest/non-forests areas (taken up under the mission) by community institutions
 - Adoption of improved fuel wood-use efficiency and alternative energy devices by households in the project area
 - Diversification of forest-based livelihoods of about 2 million households living in and around forests

Missions

- Sub-mission 1: Enhancing quality of forest cover and improving ecosystem services (4.9 million ha)
- Sub-mission 2: Ecosystem restoration and increase in forest cover (1.8 million ha)
- Sub-mission 3: Enhancing tree cover in urban and peri-urban areas (including institutional lands): 0.20 million ha
- Sub-mission 4: Agro-forestry and social forestry (increasing biomass and creating carbon sink): 3 million ha
- Sub-mission 5: Restoration of wetlands: 0.10 million ha

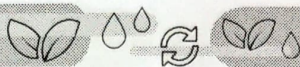
23.4.7. National Mission For Sustainable Agriculture (NMSA)

Mission Objectives

- To devise strategic plans at the agro-climatic zone level so that action plans are contextualised to

regional scales in the areas of research and development (R&D), technology and practices, infrastructure and capacity building

- To enhance agricultural productivity through customised interventions such as use of biotechnology to develop improved varieties of crops and livestock, promoting efficient irrigation systems, demonstration of appropriate technology, capacity building and skill development
- To facilitate access to information and institutional support by expanding Automatic Weather Station networks to the panchayat level and linking them to existing insurance mechanisms including the Weather Based Crop Insurance Scheme and the National Agriculture Insurance Scheme (NAIS), scaling the returns at that level
- To promote "laboratory to land" research by creating model villages and model farm units in rainfed and dryland areas
- To strategise long-term interventions for emission reduction from energy and non-energy uses by way of introduction of suitable crop varieties and farm practices, livestock and manure management
- To realise the enormous potential of growth in dryland agriculture, through the development of drought and pest resistant crop varieties, adopting resource-conserving technologies, providing institutional support to farmers and capacity building of stakeholders.
- The NMSA has identified 10 key dimensions for adaptation and mitigation:
 1. Improved Crop Seeds, Livestock and Fish Culture
 2. Water Efficiency
 3. Pest Management
 4. Improved Farm Practices
 5. Nutrient Management
 6. Agricultural Insurance
 7. Credit Support
 8. Markets



9. Access to Information
10. Livelihood Diversification

23.4.8. The National Mission on Strategic Knowledge for Climate Change (NMSKCC)

Mission Objectives

- Formation of knowledge networks among the existing knowledge institutions engaged in research and development relating to climate science and facilitating data sharing and exchange through a suitable policy framework and institutional support
- Establishment of global technology watch groups with institutional capacities to carry out research on risk minimised technology selection for developmental choices
- Development of national capacity for modeling the regional impact of climate change on different ecological zones within the country for different seasons and living standards
- Establishing research networks and encouraging research in the areas of climate change impacts on important socio-economic sectors like agriculture, health, natural ecosystems, biodiversity, coastal zones, etc.
- Generation and development of the conceptual and knowledge basis for defining sustainability of development pathways in the light of responsible climate change related actions
- Providing an improved understanding and awareness of key climate processes and the resultant climate risks and associated consequences
- To complement the efforts undertaken by other national missions, strengthen indigenous capacity for the development of appropriate technologies for responding to climate change through adaptation and mitigation and promote their utilisation by the government and societies for the sustainable growth of economies
- Creating institutional capacity for research infrastructure including access to relevant data

sets, computing and communication facilities, and awareness to improve the quality and sector specific scenarios of climate change over the Indian subcontinent

- Ensuring the flow and generation of human resources through a variety of measures including incentives to attract young scientists to climate science
- Building alliances and partnerships through global collaboration in research & technology development on climate change under international and bilateral science and technology (S&T) cooperation arrangements
- Thirteen Climate Change centers/ cells have been set up to carry activities that connect their state action plans on climate change with NMSKCC priorities of action. These are located in states of Bihar, Chhattisgarh, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Puducherry, Tamil Nadu and Telangana.

Do you know?

The concept of "green GDP" arose in the early 1990s in reaction to the deficiencies of the traditional gross domestic product (GDP) to account for the economic costs of depleted natural resources and incurred pollution, which in turn affect human welfare.

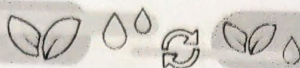
23.4.9. National Bio-Energy Mission

- According to estimates, biomass from agro and agro-industrial residue can potentially generate 25,000 MW of power in India. This can be further raised with wasteland-based integrated energy plantation and power generation systems.

National Bio energy programme

Ministry of New and Renewable Energy (MNRE) has notified that National Bioenergy Programme (NBP) from FY 2021-22 to 2025-26.

NBP will comprise the three sub-schemes namely Waste to Energy Programme, Biomass Programme, and Biogas Programme.



- Waste to Energy Programme is based on energy from urban, industrial and agricultural wastes/residues.
- Biomass Programme aims to support manufacturing of Briquettes & Pellets and promotion of biomass (nonbagasse) based cogeneration in industries
- Biogas program aims in setting up small power biogas plants

Bio Energy

- "Bioenergy is renewable energy derived from biological sources, to be used for heat, electricity, or vehicle fuel. Biofuels derived from plant materials is among the most rapidly growing renewable energy technologies."

Sources of Bio - Energy

- Existing Sources
 - Leftover organic residue
 - Leftover farm organic residue
 - Leftover forest residue
 - Leftover organic urban residue
 - Algal residue
- New Sources
 - Cultivation of short rotation energy crops
 - Social forestry

Advantages of Bio - Energy

- Capital efficient
- High energy generation potential
- Significant carbon emission reduction potential
- Substantial employment and income generation potential
- Investments & benefits remain within the country
- Sizable economic value add to GDP
- Wasteland regeneration

23.5. CLIMATE EQUITY MONITOR

- The Climate Equity Monitor provides an online dashboard for assessing, at the international level,

equity in climate action, inequalities in emissions, energy and resource consumption across the world, and ongoing climate policies of several countries.

- The Climate Equity Monitor is aimed at monitoring the performance of Annex-I Parties under the UNFCCC (developed countries) based on the foundational principles of the Climate Convention, namely equity and the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC). The performance and policies of the Non Annex-I Parties (developing countries) will be also provided for comparison.
- The analysis will be focused on the two concepts of cumulative emissions and carbon budgets.
- The website has been developed from India at the M.S Swaminathan Research Foundation (MSSRF), Chennai, the National Institute of Advanced Studies (NIAS) Bengaluru, with other independent researchers.

23.6. INDC

Conference of Parties (COP) of United Nations Framework Convention on Climate Change (UNFCCC) at 19th Session held in Warsaw in November 2013 invited all Parties to initiate domestic preparations for their INDC towards achieving the objective of the Convention and to communicate them, well in advance of the 21st session of the Conference of Parties.

The concept of 'Nationally Determined Contributions', taking into account the outcomes of both Warsaw COP 19 and Lima COP 20 has to (i) reflect the principles of equity and Common But Differentiated Responsibilities (CBDR) and (ii) the Country's contributions must be seen in a balanced and comprehensive context.

India declared a voluntary goal of reducing the emissions intensity of its GDP by 20-25%, over 2005 levels by 2020, despite having no binding mitigation obligations as per the Convention. A slew of policy measures to promote low carbon strategies and Renewable Energy have resulted in the decline



of emission intensity of our GDP by 12% between 2005 and 2010. It is a matter of satisfaction that United Nations Environment Programme (UNEP) in its Emission Gap Report 2014 has recognized India as one of the countries on course to achieving its voluntary goal.

INDC outlines the post-2020 climate actions they intend to take under a new international agreement. The INDC centre around India's policies and programmes on promotion of clean energy, especially renewable energy, enhancement of energy efficiency, development of less carbon intensive and resilient urban centres, promotion of waste to wealth, safe, smart and sustainable green transportation network, abatement of pollution and India's efforts to enhance carbon sink through creation of forest and tree cover. It also captures citizens and private sector contribution to combating climate change.

The INDC proposals are on the following:

- a. Sustainable Lifestyles
- b. Cleaner Economic Development
- c. Reduce Emission intensity of Gross Domestic Product (GDP)
- d. Increase the Share of Non Fossil Fuel Based Electricity
- e. Enhancing Carbon Sink (Forests)
- f. Adaptation
- g. Mobilizing Finance
- h. Technology Transfer and Capacity Building

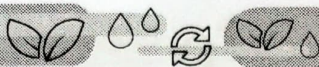
In the INDC, the country has focused on adaptation efforts, including:

- a) developing sustainable habitats;
- b) optimizing water use efficiency;
- c) creating ecologically sustainable climate resilient agricultural production systems;
- d) safeguarding the Himalayan glaciers and mountain ecosystem; and,
- e) enhancing carbon sinks in sustainably managed forests and implementing adaptation measures for vulnerable species, forest-dependent communities and ecosystems.

India's Intended Nationally Determined Contribution: At a Glance

India has submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change. Some of the salient points of the INDC are:

- To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
- To adopt a climate-friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
- To reduce the emissions intensity of its GDP by 35 per cent by 2030 from 2005 level.
- To achieve about 40 per cent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030, with the help of transfer of technology and low cost international finance, including from Green Climate Fund.
- To create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030.
- To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
- To mobilize domestic and new and additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
- To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.
- India has taken up climate actions in areas of renewable energy, energy access, and efficiency, sustainable transport including e-mobility,



sustainable agriculture, enhancing green cover, etc. India has achieved a reduction of 24% in emission intensity of its GDP between 2005 and 2016, thereby achieving its pre-2020 voluntary target (2021).

India's Revised INDC Targets

India, at UNFCCC COP 26, has made a new set of promises to take forward its climate action. The revised targets are:

- India is now committing itself to at least 45% reduction in emissions intensity of GDP (emissions per unit of GDP) from 2005 levels. The existing target was a 33% - 35% reduction.
- India is promising to ensure that at least 50% of installed electricity generation capacity in 2030 would be based on non-fossil fuel-based sources. This is an increase from the existing 40% target.
- Increase non-fossil energy capacity to 500 GW (gigawatts) by 2030.
- Reduce the total projected carbon emissions by 1 billion tonnes (BT) by 2030.
- Achieve net zero carbon by 2070.

INDIAN NETWORK ON CLIMATE CHANGE ASSESSMENT

The Indian Network on Climate Change Assessment (INCCA) was launched in October 2009 by the Ministry of Environment and Forests (MoEF) in an effort to promote domestic research on climate change, and build on the country's climate change expertise.

- INCCA is a network-based programme of the MoEF, which consists of over 120 institutions and over 250 scientists country wide is aimed at bringing in more science-based policy-making, based on measurements, monitoring and modelling.
- The INCCA has been conceptualized as a Network based Scientific Programme designed to address and assess the drivers and implications of climate change through scientific research; climate change assessments on various aspects of climate change,

associated vulnerabilities and adaptation; devise decision support systems; and build capacity towards management of climate change related risks and opportunities.

- The INCCA will carry out research on the effects of climate change in different regions and sectors in India and suggest suitable adaptation and mitigation steps.
- Objective - to have an independent body of Indian scientists who could "prepare scientific reports at the domestic level about the impact of climate change on various sectors, which can give a real picture and influence the world debate".
- Reports prepared by the INCCA will form a part of India's National Communication (Nat Com) to the United Nations Framework Convention on Climate Change (UNFCCC).

23.7.1. INCCA - First Assessment 'India: Greenhouse Gas Emissions 2007'

- The first publication to come out from the INCCA has been an updated greenhouse gas emissions inventory for India for the year 2007.
- The first Assessment of the Green House Gas emissions was released on May 11, 2010.
- INCCA prepared the country's greenhouse gas (GHG) emission data "India: Greenhouse Gas Emissions 2007" which said the country's emissions grew by 58 per cent during 1994 to 2007
- It covers the sectors of Energy, Industry, Agriculture, Land Use Land Use Change and Forest and Waste by sources and removal by sinks presented in this document.

23.7.2. INCCA - Second Assessment 'Climate Change and India: A 4x4 Assessment'

- A 4x4 Assessment' addresses the impact of climate change in 2030s to the natural resources and livelihoods of the people in the four climate sensitive regions of Himalayan region, North-East region, the Western Ghats and the Coastal plains for the 4 key sectors of Agriculture, Water, Health and Natural Ecosystems and Biodiversity.



- The 4 region, 4 sectors Assessment in short has been referred to as a 4×4 Assessment.
- The assessment examines the implications of the climate change scenario in 2030s using a regional climate model (PRECIS).
- The assessment also brings out the future areas of work to enhance the knowledge and areas of further improvement in the future assessments.
- 4 Regions: Western Ghats, Himalayan Region, Coastal India, North-East
- 4 Thrust Areas: Agriculture, Water, Forests, Human Health

Impacts

- Warmer seasons: Avg. temp rise: 2.0 deg C predicted. 1.0-4.0 deg C at extreme ranges
- Increased annual precipitation with lower frequency of rainy days; increased intensity
- Cyclonic disturbances of lower frequency; increased intensity and increased risk of storm surges
- Sea-level rise: 1.3mm/year on average

Agriculture

- Up to 50% reduction in maize yields
- 4-35% reduction in rice yields (with some exceptions)
- Rise in coconut yields (with some exceptions); reduced apple production
- Negative impacts on livestock in all regions
- Fresh water supply
- High variability predicted in water yields (from 50% increase to 40-50% reduction)
- 10-30% increased risk of floods; increased risks of droughts

Forests and natural ecosystems

- Increased net primary productivity
- Shifting forest borders; species mix; negative impact on livelihoods and biodiversity

Human health

- Higher morbidity and mortality from heat stress and vector/water-borne diseases
- Expanded transmission window for malaria

23.8. NATIONAL COMMUNICATION (NATCOM)

- In pursuance of the implementation of the provisions of the Convention, India's Initial National Communication (NATCOM) to the UNFCCC has been initiated in 2002 funded by the Global Environment Facility under its enabling activities programme through the United Nations Development Programme, New Delhi.

Parties to the Convention are enjoined to communicate the following information to the Secretariat of the Conference of Parties:

- A national inventory of anthropogenic emissions by sources and removal by sink of all GHGs not controlled by the Montreal protocol, to the extent its capacities, permit, using comparable methodologies to be promoted and agreed upon by the Conference of Parties.
- A general description of steps taken or envisaged by the Party to implement the Convention.
- Any other information relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including if feasible, material relevant for calculation of global emission trends.
- The National Communication process envisages comprehensive scientific and technical exercises for preparation of inventories of greenhouse gases of anthropogenic origin, reduction of uncertainties in these estimations and vulnerability assessment and adaptation due to climate change, besides other related information of India's initiatives which address the objectives of the Convention.
- Towards preparation of National Communication, a broad participatory approach involving research



institutions, technical institutions, universities, government departments, and non governmental and private organizations has been adopted, necessitated by vast regional diversity and sector complexities in India.

Implementation arrangements

- The Ministry of Environment and Forests (MoEF) is implementing and executing agency of the project.

Work Programme envisaged

- Development of comprehensive inventory for the base year 1994 and improvement of its reliability vis-à-vis earlier estimates. This would entail reducing uncertainties of GHG emission coefficients in key source categories.

Identification of key steps to be taken towards implementing the Convention.

- Vulnerability and adaptation assessment for presentation of information on specific needs and concerns arising from the adverse impacts of climate change.
- Creation of reliable and comprehensive database for all the outputs produced through the establishment of a 'Data Centre' (DC). This information will be accessible on the Internet.
- Enhancement of capacity to respond to projected climate change through the preparation of a 'Targeted Research Proposal' for developing a medium to long-term action plan.

GHG Inventory Estimations

- In accordance with the provisions of Article-4 and 12.1 of UNFCCC, preparation of inventories of a basket of gases has been started for the areas of energy, industrial processes, agriculture land use and land use change and forestry (LULUCF) and waste.
- The gases to be inventoried include carbon dioxide methane, nitrous oxide, hydrofluorocarbons,

perfluorocarbon and sulphur hexafluoride released from various anthropogenic sources of the base year 1994.

- This is in addition to estimating historical trends of GHG growth as a part of the initial National Communication to UNFCCC.
- The estimation of national GHG inventories for all sectors is based on the 1996 guidelines of the 'Intergovernmental Panel on Climate Change' (IPCC) and as good practices guidelines.

Do you know?

Strengthening of ecological security is one of the goal of the Mahatma Gandhi Rural Employment Guarantee Programme (MGNREGA). MGNREGA is designed to strengthen ongoing efforts in the areas of water harvesting, watershed management and soil health care and enhancement.

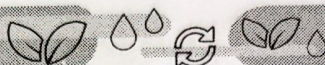
23.9. INDIA'S POLICY STRUCTURE RELEVANT TO GHG MITIGATION

1. Integrated Energy Policy

- India has in place a detailed policy, regulatory, and legislative structure that relates strongly to GHG mitigation: The Integrated Energy Policy was adopted in 2006.
- Some of its key provisions are:
 - Promotion of energy efficiency in all sectors
 - Emphasis on mass transport
 - Emphasis on renewables including biofuels plantations
- Accelerated development of nuclear and hydropower for clean energy
- Focused R&D on several clean energy related technologies.

2. The Rural Electrification Policy, 2006

- It promotes renewable energy technologies where grid connectivity is not possible or cost-effective. The New and Renewable Energy Policy, 2005,



promotes utilization of sustainable, renewable energy sources, and accelerated deployment of renewables through indigenous design, development and manufacture.

- The National Environment Policy, 2006, and the Notification on Environment Impact Assessment (EIA), 2006, reform India's environmental assessment regime. A number of economic activities are required to prepare environment impact assessments, and environment management plans, which are appraised by regulatory authorities prior to start of construction. The EIA provisions strongly promote environmental sustainability

Do you know?

Rajiv Gandhi Environment Award for Clean Technology is given to industrial units that make a significant contribution towards the development of new or the innovative modification of existing technologies or adoption and use of clean technologies and practices that substantially reduce or prevent environmental pollution.

Several other provisions

- It relates to reforming energy markets to ensure that energy markets are competitive, and energy prices reflect true resource costs. These include: Electricity Act 2005, Tariff Policy 2003, Petroleum & Natural Gas Regulatory Board Act, 2006, etc.
- The provisions taken together are designed to:
 - Remove entry barriers and raise competition in exploration, extraction, conversion, transmission and distribution of primary and secondary energy
 - Accomplish price reform, through full competition at point of sale
 - Promote tax reform to promote optimal fuel choices
 - Augment and diversify energy options, sources and energy infrastructure

- Provide feed-in tariffs for renewables (solar, wind, biomass cogeneration)
- Strengthen, and where applicable, introduce independent regulation

23.10. INTRODUCTION OF LABELLING PROGRAMME FOR APPLIANCES

- An energy labelling programme for appliances was launched in 2006, and comparative star-based labelling has been introduced for fluorescent tube-lights, air conditioners, refrigerators, and distribution transformers.
- The labels provide information about the energy consumption of an appliance, and thus enable consumers to make informed decisions. The Bureau of Energy Efficiency has made it mandatory for refrigerators to display energy efficiency label and is expected to do so for air conditioners as well. The standards and labelling programme for manufacturers of electrical appliances is expected to lead to significant savings in electricity annually.

23.11. ENERGY CONSERVATION BUILDING CODE

- An Energy Conservation Building Code (ECBC) was launched in May, 2007, which addresses the design of new, large commercial buildings to optimize the buildings' energy demand based on their location in different climatic zones. Commercial buildings are one of the fastest growing sectors of the Indian economy, reflecting the increasing share of the services sector in the economy.
- Nearly one hundred buildings are already following the Code, and compliance with the Code has been incorporated into the mandatory Environmental Impact Assessment requirements for large buildings.
- It has been estimated that if all the commercial space in India every year conform to ECBC norms, energy consumption in this sector can be reduced



by 30-40%. Compliance with ECBC norms is voluntary at present but is expected to soon become mandatory.

- Ministry of Power in 2021 also started rating net-zero buildings with its Shunya scheme where the BEE gives certification of net-zero buildings. This is given if the buildings can offset their building energy requirements with renewable energy.

23.11.1. Green Building

- Buildings are one of the major pollutants that affect urban air quality and contribute to climate change.
- Human Habitats (Buildings) interact with the environment in various ways. Throughout their life cycles, from construction to operation and then demolition, they consume resources in the form of energy, water, materials, etc. and emit wastes either directly in the form of municipal wastes or indirectly as emissions from electricity generation.

Green building is the essence of which would be to address all the pollution related issues of a building in an integrated and scientific manner.

- A green building depletes as little of the natural resources during its construction and operation.
- The aim of a green building design is to:
 - Minimize the demand on non-renewable resources and maximize the utilization efficiency of these resources when in use, and
 - Maximize reuse and recycling of available resources
 - Utilization of renewable resources.
- It costs a little more to design and construct a green building.
- However, it costs less to operate a green building that has tremendous environmental benefits and provides a better place for the occupants to live and work in.
- It maximizes the use of efficient building materials and construction practices; optimizes the use of

on-site sources and sinks by bio-climatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air-conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions.

- It is evolved through a design process that requires all concerned (the architect and landscape designer and the air conditioning, electrical, plumbing, and energy consultants) to work as a team to address all aspects of building and system planning, design, construction, and operation.
- They critically evaluate the impacts of each design decision on the environment and arrive at viable design solutions to minimize the negative impacts and enhance the positive impacts on the environment.
- In sum, the following aspects of the building design are looked into in an integrated way in a green building:
 - Building system designed in a way to efficiently use HVAC (heating ventilation and air conditioning), lighting, electrical, and water heating.
 - Integration of renewable energy sources to generate energy onsite.
 - Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, etc.) for Water and waste management.
 - Indoor environmental quality (maintains indoor thermal and visual comfort and air quality)

23.11.2. Green Rating for Integrated Habitat Assessment (GRIHA)

- GRIHA is a Sanskrit word meaning - 'Abode'.
- GRIHA has been conceived by TERI and developed jointly with the Ministry of New and Renewable Energy, Government of India.



- The green building rating system devised by TERI and the MNRE is a voluntary scheme.

Objective

- The primary objective of the rating system is to help design green buildings and, in turn, help evaluate the 'greenness' of the buildings.

Aim

- The rating system aims to achieve efficient resource utilization, enhanced resource efficiency, and better quality of life in the buildings.

Rating Tool

- GRIHA is a rating tool that helps people assess the performance of their building against certain nationally acceptable benchmarks and is suitable for all kinds of buildings in different climatic zones of the country.
- Going by the old adage 'what gets measured, gets managed', GRIHA attempts to quantify aspects such as energy consumption, waste generation, renewable energy adoption, etc. so as to manage, control and reduce the same to the best possible extent.
- It will evaluate the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'.
- The rating system, based on accepted energy and environmental principles, will seek to strike a balance between the established practices and emerging concepts, both national and international.
- The guidelines/criteria appraisal may be revised every three years to take into account the latest scientific developments during this period.

The basic features

- The system has been developed to help 'design and evaluate' new buildings (buildings that are still at the inception stages).

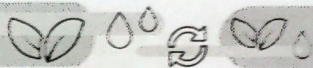
- A building is assessed based on its predicted performance over its entire life cycle – inception through operation.
- The stages of the life cycle that have been identified for evaluation are:

Rating system

- GRIHA rating system consists of 34 criteria categorized under 4 categories.
- They are
 1. Site Selection and Site Planning,
 2. Conservation and efficient utilization of resources,
 3. Building operation and maintenance, and
 4. Innovation points.
- Eight of these 34 criteria are mandatory, four are partly mandatory, while the rest are optional. Each criterion has a number of points assigned to it.
- It means that a project intending to meet the criterion would qualify for the points. Different levels of certification (one star to five stars) are awarded based on the number of points earned. The minimum points required for certification is 50.

The benefits

- On a broader scale, this system, along with the activities and processes that lead up to it, will benefit the community at large with the improvement in the environment by reducing GHG (greenhouse gas) emissions, reducing energy consumption and the stress on natural resources.
 - Reduced energy consumption without sacrificing the comfort levels
 - Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion etc.
 - Reduced air and water pollution (with direct health benefits)



- Reduced water consumption
- Limited waste generation due to recycling and reuse
- Reduced pollution loads
- Increased user productivity
- Enhanced image and marketability

The challenges

- The Indian building industry is highly decentralized with people and/ or groups engaged in design, construction, equipment provision, installation, and renovation working together.
- Each group may be organized to some extent, but there is limited interaction among the groups, thus disabling the integrated green design and application process.
- Hence, it is very important to define and quantify sustainable building practices and their benefits.
- It is also important to separate the role of different participants in ensuring that the building consumes minimal resources over its entire life cycle and leaves behind a minimal environmental footprint.

ENERGY AUDITS OF LARGE INDUSTRIAL CONSUMERS

- In March 2007 the conduct of energy audits was made mandatory in large energy-consuming units in nine industrial sectors. These units, notified as "designated consumers" are also required to employ "certified energy managers", and report energy consumption and energy conservation data annually.

23.13. MASS TRANSPORT

- The National Urban Transport Policy emphasizes extensive public transport facilities and non-motorized modes over personal vehicles. The expansion of the Metro Rail Transportation System in Delhi and other cities (Chennai, Bangalore, Jaipur, etc) and other mass transit systems, such as the Metro Bus project in

Bangalore, are steps in its implementation. The state government of Maharashtra recently announced that it will impose a congestion tax to discourage the use of private cars in cities where it has created "sufficient public transport capacity".

23.13.1. Clean Air Initiatives

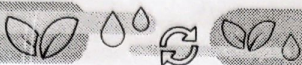
- In urban areas, one of the major sources of air pollution is emissions from transport vehicles.
- Steps taken to reduce such pollution include
 - (i) introduction of compressed natural gas (CNG) in Delhi and other cities;
 - (ii) Retiring old, polluting vehicles; and
 - (iii) Strengthening of mass transportation.
- Some state governments provide subsidies for purchase and use of electric vehicles. For thermal power plants, the installation of electrostatic precipitators is mandatory. In many cities, polluting industrial units have either been closed or shifted from residential areas.

23.14. PROMOTION OF ENERGY SAVING DEVICES

- The Bureau of Energy efficiency has introduced "The Bachat Lamp Yojana", a programme under which households may exchange incandescent lamps for CFLs (compact fluorescent lamps) using clean development mechanism (CDM) credits to equate purchase price.
- Some states have made mandatory the installation of solar water heaters in hospitals, hotels and large government and commercial buildings. Subsidy is provided for installation of solar water heaters in residential buildings.

23.15. PROMOTION OF BIOFUELS

- The Biodiesel Purchase Policy mandates biodiesel procurement by the petroleum industry. A mandate on Ethanol Blending of Gasoline requires 5% blending of ethanol with gasoline from 1st January, 2003, in 9 States and 4 Union Territories



- In June 2022, the Central Government approved amendments to the National Policy on Biofuels, 2018 to advance the target of 20% ethanol blending in petrol to Ethanol Supply Year (ESY) 2025-26 from earlier 2030. Additional feedstocks were made eligible as a source for the production of biofuels.

23.16. INDIAN SOLAR LOAN PROGRAMME

- In April 2003, the United Nations Environment Programme ("UNEP") initiated a, three-year Programme, credit facility in Southern India to help rural households finance the purchase of Solar Home Systems.
- Canara Bank and Syndicate Bank, along with their eight associate Regional Rural Banks, partnered with UNEP to establish and run a Loan Programme through their branch offices across Karnataka State and part of the neighbouring Kerala State.
- In addition to providing financial support in the form of interest rate subsidies for borrowers, UNEP provides assistance with technical issues, vendor qualification and other activities to develop the institutional capacity for this type of finance.

23.17. NATIONAL INITIATIVE ON CLIMATE RESILIENT AGRICULTURE (NICRA)

- The ICAR has launched National Initiative on Climate Resilient Agriculture (NICRA) during 2010-11 with an outlay of Rs.350 crores for the XI Plan.
- This initiative will primarily enhance the resilience of Indian Agriculture covering crops, livestock and fisheries.

23.17.1. Objective

- To enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies

Project Components

- The project is comprised of four components.
 - 1) Strategic research on adaptation and mitigation
 - 2) Technology demonstration on farmers' fields to cope with current climate variability
 - 3) Sponsored and competitive research grants to fill critical research gaps
 - 4) Capacity building of different stake holders

Strategic Research

- The strategic research has been planned at leading research institutes of ICAR in a network mode covering crops, horticulture, livestock, natural resource management and fisheries sectors.
- To begin with, the project is focusing on crops like wheat, rice, maize, pigeonpea, groundnut, tomato, mango and banana; cattle, buffalo and small ruminants among livestock and both marine and freshwater fish species of economic importance.
- The major research themes are:
 - Vulnerability assessment of major production zones
 - Linking weather based agro-advisories to contingency planning
 - Assessing the impacts and evolving varieties tolerant to key climatic stresses (drought, heat, frost, flooding, etc.) in major food and horticulture crops
 - Continuous monitoring of greenhouse gases in open field conditions in major production systems
 - Evolving adaptation and mitigation strategies through enhancing water and nutrient use efficiency and conservation agriculture
 - Studying changes in pest dynamics, pest/pathogen-crop relationships and emergence of new pests and pathogens under changing climate
 - Adaptation strategies in livestock through nutritional and environmental manipulations



- Harnessing the beneficial effects of temperature in inland and marine fisheries through better understanding of the spawning behaviour.
- Seven major research institutes of the ICAR will work in unison to evolve coping technologies with Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad as the lead centre.
- Best-bet and cost-effective technologies to cope with climate variability will be demonstrated on farmers' fields in 100 most vulnerable districts of the country.
- The technologies include rain water harvesting and its judicious use, in-situ moisture conservation, drought management strategies, seed and fodder banks, timely and precision agriculture, effective agro-advisory system using Information Communication Technology kiosks.
- Small and marginal farmers in rain-fed, coastal and hill areas will benefit more in view of the focused attention in these regions.
- Capacity building of scientists in frontier areas is another core activity of the project.
- To prepare all stakeholders to face challenges, multi-pronged awareness generation programs on issues of climate change are planned.

FAME-INDIA PROGRAMME

For Adoption and Manufacturing of (Hybrid) and Electric Vehicles (FAME India) scheme rolled out in April, 2015 by Union Minister for Heavy Industries and Public Enterprises

The scheme will help promote use of electric and hybrid vehicles, and initially, a subsidy of 30% will be provided to the buyers.

Phased replacement of fossil fuel-based vehicles with those based on latest technologies will lead to a net saving of Rs 14,000 crore.

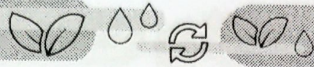
The scheme is proposed to be implemented over six years, till 2020, which looks at sales of electric and hybrid vehicles up to 60-70 lakh units per year.

23.19. LONG TERM ECOLOGICAL OBSERVATORIES (LTEO)

- Long Term Ecological Observatories (LTEO) for Climate Change Studies are one of the components under the 'Climate Change Action Programme' with an outlay of Rs. 40 crores in the 12th Plan Period.
- A Science Plan of LTEO was released during the 21st Conference of Parties to the United Nations Framework Convention on Climate Change at Paris in December 2015.
- First phase of the LTEO Programme includes creating a network of field sites to assess the health of eight different biomes of the country namely; Western Himalaya, Eastern Himalaya, North-Western Arid Zone, Central Indian Forests, Western Ghats, Andaman & Nicobar Islands, Jammu & Kashmir and Sundarbans.
- LTEO Programme aims to understand the biophysical and anthropogenic drivers of ecosystem change in the selected biomes and their effects on social- ecological responses through a network of scientific institutions.
- Activities include experimental work to assess the change of structure and function in the natural ecosystems, identification of patterns and drivers of change in the natural ecosystems by monitoring populations of fresh water fish, birds, mammals, herbivores & carnivores, animal movements, soil processes in forests & grasslands, biophysical climatic variables, etc.

23.20. THE NATIONAL ADAPTATION FUND FOR CLIMATE CHANGE (NAFCC)

- The National Adaptation Fund for Climate Change (NAFCC) is a Central Sector Scheme set up in 2015-16. The aim of NAFCC is to support concrete adaptation activities which mitigate the adverse effects of climate change. The activities under this scheme are implemented in a project mode. The projects related to adaptation in sectors such as agriculture, animal husbandry, water, forestry, tourism etc. are eligible for funding under NAFCC.



National Bank for Agriculture and Rural Development (NABARD) is the National Implementing Entity (NIE).

23.21. INDIA COOLING ACTION PLAN

- India is the first country in world to develop such a document (ICAP) and lists out actions which can help reduce the cooling demand. Cooling requirement is cross sectoral and an essential part for economic growth encompassing inter alia reduction of cooling demand, refrigerant transition, enhancing energy efficiency and better technology options with a 20 year time horizon.
- “The overarching goal of ICAP is to provide sustainable cooling and thermal comfort for all while securing environmental and socio-economic benefits for the society. This will also help in reducing both direct and indirect emissions.”
- The India Cooling Action seeks to
 - (i) reduce cooling demand across sectors by 20% to 25% by 2037-38,
 - (ii) reduce refrigerant demand by 25% to 30% by 2037-38,
 - (iii) Reduce cooling energy requirements by 25% to 40% by 2037-38,
 - (iv) recognize “cooling and related areas” as a thrust area of research under national S&T Programme,
 - (v) training and certification of 100,000 servicing sector technicians by 2022-23, synergizing with Skill India Mission.

Benefits

- (i) Thermal comfort for all – provision for cooling for EWS and LIG housing,
- (ii) Sustainable cooling – low GHG emissions related to cooling,
- (iii) Doubling Farmers Income – better cold chain infrastructure – better value of produce to farmers, less wastage of produce,
- (iv) Skilled workforce for better livelihoods and environmental protection,

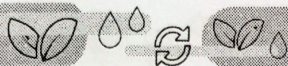
- (v) Make in India – domestic manufacturing of air-conditioning and related cooling equipment's,
- (vi) Robust R&D on alternative cooling technologies – to provide push to innovation in cooling sector.

The Nagar Van (Urban Forests) Scheme announced on World Environment Day 2020 for creation of 200 Nagar Van, on forest land by adopting a collaborative approach, involving various agencies like forest and other departments, NGOs, Corporate Bodies, Industries etc.. The primary objective is to create forested area in cities with Municipal Corporation, which will act as lungs of the cities.

School Nursery scheme aims at involving school students from the young age in nursery and plantation operations. objective of the scheme is to inculcate the spirit of forest and environment in the mind of young students.

23.22. FOREST LANDSCAPE RESTORATION (FLR) AND BONN CHALLENGE

- Forest landscape restoration (FLR) and Bonn Challenge in India is launched by MoEFCC in partnership with IUCN. The project aims to develop and adapt best practices and monitoring protocols for the Indian states and build capacity within the five pilot states on FLR and Bonn Challenge.
- It is launched in pilot phase for 3.5 years in the States of Haryana, Madhya Pradesh, Maharashtra, Nagaland and Karnataka. This will be eventually scaled up across the country through subsequent phases of the project.
- The Bonn Challenge is a global effort to bring 150 million hectares of the world's deforested and degraded land into restoration by 2020, and 350 million hectares by 2030.
- At the UNFCCC Conference of the Parties (COP) 2015 in Paris, India also joined the voluntary Bonn



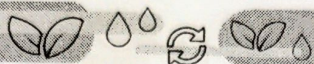
Challenge pledge to bring into restoration 13 million hectares of degraded and deforested land by the year 2020, and additional 8 million hectares by 2030. India's pledge is one of the largest in Asia.

23.23. OTHER "CRITICAL INITIATIVES"

- In addition, India has 24 other "Critical Initiatives" in the anvil, for which detailed plans and an institutional framework is being prepared

Type	Initiative
Energy Efficiency in Power Generation	Super critical technologies Integrated Gasification Combined Cycle (IGCC)
Technology	Natural Gas based Power Plants Closed Cycle Three Stage Nuclear Power Programme Efficient Transmission and Distribution Hydropower
Other Renewable Energy Technologies Programmes	RETs for power generation Biomass based popup generation technologies Small scale Hydropower Wind Energy Grid connected systems RETs for transportation and industrial fuels
Disaster Management Response to Extreme Climate Events	Reducing risk to infrastructure through better design Strengthening communication networks and disaster management facilities
Protection of Coastal Areas	Undertake measures for coastal protection and setting up Early Warning System Development of a regional ocean modelling system High resolution coupled ocean-atmosphere variability studies in tropical oceans Development of a high-resolution storm surge model for coastal regions Development of salinity-tolerant crop cultivars Community awareness on coastal disasters and necessary action; Timely forecasting, cyclone and flood warning systems Enhanced plantation and regeneration of mangroves and coastal forests
Health Sector	Provision of enhanced public health care services and assessment of increased burden of disease due to climate change
Creating appropriate capacity at different levels of Government	Building capacity in the Central, State and other at the local level to assimilate and facilitate the implementation of the activities of national plan





CHAPTER - 24



CLIMATE CHANGE ORGANIZATIONS

24.1. UNFCCC

- UN Summit Conference on Environment and Development (UNCED) held in Rio de Janeiro in June 1992 adopted, by consensus, the first multilateral legal instrument on Climate Change, the UN Framework Convention on Climate Change or the UNFCCC.
- In 1992, countries joined UNFCCC, to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable. There are now 195 Parties to the Convention.
- The UNFCCC secretariat supports all institutions involved in the international climate change negotiations, particularly the Conference of the Parties (COP), the subsidiary bodies (which advise the COP), and the COP Bureau (which deals mainly with procedural and organizational issues arising from the COP and also has technical functions).
- All subsequent multilateral negotiations on different aspects of climate change, including both adaptation and mitigation, are being held based on the principles and objectives set out by the UNFCCC.

Timeline of International Climate Policy

The following is the Key Milestones in the Evolution of International Climate Policy by UNFCCC. It has only the timeline. The detailed description of the

concepts, projects, themes will be discussed later in this chapter (few terminologies are explained in brief in the glossary).

1988

WMO and UNEP established Intergovernmental Panel on Climate Change

1990

IPCC released the first assessment report which stated emissions resulting from human activities are substantially increasing the atmospheric concentrations of greenhouse gases.

The second World Climate Conference for a global treaty took place.

UN General Assembly established the Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change.

1992

United Nations Framework Convention on Climate Change along with two sister Conventions the UN Convention on Biological Diversity and the Convention to Combat Desertification adopted in UN conference on environment and development (earth summit) in Rio De Janeiro.

1994

The United Nations Framework Convention on Climate Change entered into force. Countries that sign the treaty are known as 'Parties'. With 196



Parties, the UNFCCC has near-universal membership. Parties meet annually at the Conference of the Parties (COP) to negotiate multilateral responses to climate change.

1995

Germany presides over the first Conference of the Parties (COP 1) in Berlin, where Parties agreed that commitments in the Convention were 'inadequate' for meeting Convention objectives. The Berlin Mandate established a process to negotiate strengthened commitments for developed countries, thus laying the groundwork for the Kyoto Protocol.

1996

The UNFCCC secretariat relocated from Geneva to Bonn. With that Bonn became an international sustainability hub and home to 18 UN organizations

1997

3rd Conference of the Parties adopted the Kyoto Protocol, the world's first greenhouse gas emissions reduction treaty.

2001

In Sixth Conference of the Parties, Bonn, parties agreed for the operational rule book for the 1997 Kyoto Protocol.

2001

Seventh Conference of the Parties resulted in the Marrakesh Accords, setting the stage for ratification of the Kyoto Protocol. This formalized agreement on operational rules for International Emissions Trading, the Clean Development Mechanism and Joint Implementation along with a compliance regime and accounting procedures.

2005

The European Union Emissions Trading Scheme, the first and largest emissions trading scheme in the world was launched.

Kyoto Protocol Entered into Force. Following the entry into force of the Kyoto Protocol, the eleventh Conference of the Parties (COP 11) for the first time

is held in conjunction with the first Conference of the Parties serving as the Meeting of the Parties (CMP 1).

2006

The Clean Development Mechanism, a key mechanism under the Kyoto Protocol was opened for business.

Twelfth Conference of the Parties held in Kenya, resulted in creation of the Subsidiary Body for Scientific and Technological Advice SBSTA. It is mandated to undertake a programme to address impacts, vulnerability and adaptation to climate change - the Nairobi Work Programme NWP.

2007

Thirteenth Conference of the Parties adopted the Bali Road Map, including the Bali Action Plan, charting the course for a new negotiating process to address climate change. The Plan has five main categories: shared vision, mitigation, adaptation, technology and financing.

2008

Joint Implementation, a key mechanism under the Kyoto Protocol was started.

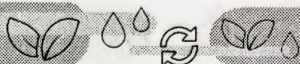
Fourteenth Conference of the Parties in Poznan, Poland, delivered important steps towards assisting developing countries, including the launch of the Adaptation Fund under the Kyoto Protocol and the Poznan Strategic Programme on Technology Transfer.

2009

Fifteenth Conference of the Parties in Copenhagen, Denmark, produced the Copenhagen Accord. Developed countries pledge up to USD 30 billion in fast-start finance for the period 2010-2012.

2010

Sixteenth Conference of the Parties resulted in the Cancun Agreements, a comprehensive package by governments to assist developing nations in dealing with climate change. The Green Climate Fund, the Technology Mechanism and the Cancun Adaptation Framework are established.



2011

Seventeenth Conference of the Parties, governments committed for a new universal climate change agreement by 2015 for the period beyond 2020, leading to the launch of the Ad Hoc Working Group on the Durban Platform for Enhanced Action.

Momentum for Change, a special initiative of the UNFCCC launched.

2012

Eighteenth Conference of the Parties, governments agree to speedily work toward a universal climate change agreement by 2015 and to find ways to scale up efforts before 2020 beyond existing pledges to curb emissions. They also adopted the Doha Amendment, launching a second commitment period of the Kyoto Protocol.

Nineteenth Conference of the Parties resulted in the Warsaw Outcomes, including a rule book for reducing emissions from deforestation and forest degradation (REDD) and a mechanism to address loss and damage caused by long-term climate change impacts.

2014

UN Secretary-General hosted a climate summit in New York, with Heads of State and Government, business, finance, civil society and local leaders to mobilize action and ambition on climate change in advance of COP 21 in Paris in 2015.

2015

195 nations agreed to combat climate change and unleash actions and investment towards a low-carbon, resilient and sustainable future in COP 21. The Paris Agreement for the first time brings all nations into a common cause based on their historic, current and future responsibilities.

2016

A crucial outcome of the COP 22, Marrakech climate conference was to move forward on writing the rule book of the Paris Agreement. The Conference

successfully demonstrated to the world that the implementation of the Paris Agreement is underway, and launched the Marrakech Partnership for Global Climate Action.

2017

The 2017 UN Climate Change Conference COP 23 is the first COP presided over by a small island developing state, Fiji.

In COP 23, nations agreed the next steps towards higher climate action ambition before 2020. Delegates launched the 'Talanoa Dialogue' to help set the stage for the revising upwards of national climate action plans needed to put the world on track to meet pre-2020 ambition and the long-term goals of the Paris Agreement.

One Planet Summit held in Paris resulted in Finance Commitments. Financial flows are crucial for countries' national climate action plans under the Paris Agreement.

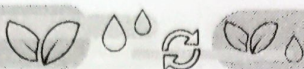
2018

A special Global Warming of 1.5C report by the Intergovernmental Panel on Climate Change confirms the need to maintain the strongest commitment to the Paris Agreement's aims of limiting global warming to stave off the worst impacts of climate change, which include more frequent and more severe droughts, floods and storms.

In Poland, governments adopted a robust set of guidelines for implementing the landmark 2015 Paris Climate Change Agreement. The agreed 'Katowice Climate Package' operationalized the climate change regime contained in the Paris Agreement, promotes international cooperation and encourages greater ambition.

2019

To boost ambition and to accelerate actions to implement the Paris Agreement, UN Secretary-General hosted a UNSG's Climate Action Summit in New York. The Summit took place exactly one year before countries are set to enhance their national climate pledges under the Paris Agreement.



2020

The COP 26 UN climate change conference set to take place in Glasgow in November has been postponed due to COVID-19.

2021

The COP Bureau, took place on November 2021, hosted in Glasgow by the UK in partnership with Italy. The COP26 holds significance as it aims to finalize the Paris rulebook, following the 2019 COP25 summit in Madrid, where many issues had not been agreed and had been pushed into the next year under the "Rule 16" of the UN climate process. The conference ended with all 197 parties to the UNFCCC agreeing to Glasgow Climate Pact (GCP), the global agreement which will accelerate action on climate this decade and completes the Paris Rulebook. The pact is to limit global warming to 1.5 degree Celsius by 2030, as agreed under the 2015 Paris Agreement and cut Global greenhouse gas emissions by 45 per cent by 2030 and to zero overall by 2050.

2022

It enhanced the development of Glasgow Climate Pact of COP26 and pave the way for higher ambition on mitigation, adaptation and climate finance, with focus on loss and damage. It also paved the way for introduction of Sharm el Shaikh plan.

2023

COP 28 in UAE

24.2. KYOTO PROTOCOL: COP-3.

- By 1995, countries realized that emission reductions provisions in the Convention were inadequate. They launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol.
- The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997. Due to a complex ratification process, it entered into force on 16 February 2005.
- In short, the Kyoto Protocol is what "operationalizes" the Convention. It commits industrialized countries to stabilize greenhouse

gas emissions based on the principles of the Convention.

- The major distinction between the Protocol and the Convention is that while the Convention encouraged industrialized countries to stabilize GHG emissions, the Protocol commits them to do so.

24.2.1. Targets

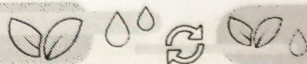
- KP, as it is referred to in short, sets binding emission reduction targets for 37 industrialized countries and the European community in its first commitment period.
- It only binds developed countries because it recognizes that they are largely responsible for the current high levels of GHG emissions in the atmosphere, which are the result of more than 150 years of industrial activity.
- KP places a heavier burden on developed nations under its central principle: that of "common but differentiated responsibility".
- Overall, these targets add up to an average five per cent emissions reduction compared to 1990 levels over the five-year period 2008 to 2012.

The architecture of the KP regime: What KP tick?

- The Kyoto Protocol is made up of essential architecture that has been built and shaped over almost two decades of experience, hard work and political will. The beating heart of KP is made up of:
 1. Reporting and verification procedures;
 2. Flexible market-based mechanisms, which in turn have their own governance procedures; and
 3. A compliance system.
- So, two things make KP tick.

1. Emissions Reduction Commitments

- The first was binding emissions reduction commitments for developed country parties. This meant the space to pollute was limited.



- Greenhouse gas emissions, most prevalently carbon dioxide, became a new commodity. KP now began to internalize what was now recognized as an unpriced externality.

2. Flexible Market Mechanisms

- This leads us to the second, the flexible market mechanisms of the KP, based on the trade of emissions permits. KP countries bound to targets have to meet them largely through domestic action— that is, to reduce their emissions onshore.
- But they can meet part of their targets through three “market-based mechanisms” that ideally encourage GHG abatement to start where it is most cost-effective-- for example, in the developing world. Quite simply, it does not matter where emissions are reduced, as long as they are removed from the planet’s atmosphere.
- The Kyoto Flexible Market Protocol mechanisms:

Joint Implementation (JI)

The Clean Development Mechanism (CDM)

Emission Trading

24.2.2. The objectives of Kyoto mechanisms:

- Its objective is to facilitate, promote and enforce compliance with the commitments under the Protocol.
- Stimulate sustainable development through technology transfer and investment
- Help countries with Kyoto commitments to meet their targets by reducing emissions or removing carbon from the atmosphere in other countries in a cost-effective way
- Encourage the private sector and developing countries to contribute to emission reduction efforts

Joint Implementation:

- The mechanism known as “joint implementation”, allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (Annex B Party – developed country) to earn emission reduction units (ERUs) from an

emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO₂, which can be counted towards meeting its Kyoto target.

- Joint implementation offers Parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments, while the host Party benefits from foreign investment and technology transfer.
- Projects starting as from the year 2000 may be eligible as JI projects, ERU issued from 2008

Clean Development mechanism:

- The Clean Development Mechanism (CDM) allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries.
- It is the first global, environmental investment and credit scheme of its kind, providing standardized emissions offset instrument, CERs
- Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO₂, which can be counted towards meeting Kyoto targets.

Example

- A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy-efficient boilers. The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.
- Most of the CDM projects were implemented in China and India as climate in these countries is favorable for implementing projects for almost all the spheres such as Agriculture, Waste handling and disposal, Afforestation and reforestation. Such CDM projects are also to be supported by the approval of Annex B countries - those which have quantified obligations according Kyoto Protocol.



Carbon Trading:

- Carbon trading is the name given to the exchange of emission permits. This exchange may take place within the economy or may take the form of international transaction.
- Two types of Carbon trading:
 1. Emission trading and
 2. Offset trading.

Emission trading/ 'cap-and-trade',

- Emission permit is known alternatively as carbon credit. For each Annex I country, the protocol has assigned a fixed amount of carbon emission in the agreement. This amount is actually the amount of emission which is to be reduced by the concerned country.
- On the other hand, it implies that the country was permitted to emit the remaining amount. This emission allowance is actually one kind of carbon credit.
- The total amount of allowance is then subdivided into certain units. The units are expressed in terms of carbon-equivalent. Each unit gives the owner the right to emit one metric tonne of carbon dioxide or other equivalent green-house gases.

Offset Trading/ Carbon Project/ 'baseline-and credit' trading:

- Another variant of carbon credit is to be earned by a country by investing some amount of money in such projects, known as carbon projects, which will emit lesser amount of green-house gas in the atmosphere.
- For example, suppose a thermal plant of 800 megawatt capacity emit 400 carbon-equivalent in the atmosphere. Now a country builds up a 800 megawatt wind energy plant which does not generate any amount of emission as an alternative of the thermal plant. Then by investing in this project the country will earn 400 carbon-equivalent.
- According to an estimate made by the World Bank's Carbon Finance Unit, volume of carbon

trade through Emission Trading route alone had shown a 240 percent increase in 2005 over the previous year.

Benefits of Flexible Market Mechanisms

- This has the parallel benefits of stimulating green investment in developing countries and of including the private sector in this endeavour to cut and hold steady GHG emissions at a safe level.
- It also makes "leap-frogging" more economical that is, the possibility to skip older, dirtier technology for newer, cleaner infrastructure and systems, with obvious longer-term benefits.
- The Kyoto Protocol compliance mechanism is designed to strengthen the Protocol's environmental integrity, support the carbon market's credibility and ensure transparency of accounting by Parties.

24.2.3. Non-Compliance of Kyoto And Pe

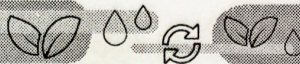
- Like most things in life, failure to comply with the Protocol carries penalties.
- If a country does not meet the requirements for measurements and reporting said country loses the privilege of gaining credit through joint implementation projects.
- If a country goes above its emissions cap, and does not try to make up the difference through any of the mechanisms available, then said country must make up the difference plus an additional thirty percent during the next period.
- The country could also be banned from participating in the 'cap and trade' program.

24.3. BALI MEET

- Bali Meet was the meeting of 190 countries that are party to a UN treaty on climate change held in December 2007.

Objectives:

- The treaty's aim was to push the world towards taking action that reduces the greenhouse gases in the atmosphere which cause climate change.



- Bali was to discuss what happens after 2012—what are countries expected to do after the first phase of Kyoto ends in 2012.
- As per developed countries, after 2012, even the developing countries like India and China, which are increasing their emissions as they grow economically, also undertake some kind of emission cuts. This meant a complete overhaul of the existing UN treaty.
- In Bali, the nations have decided upon a new set of principles that will, help the countries decide a post-2012 deal.

24.3.1. Bali Roadmap

- The participating nations adopted the Bali Road Map as a two-year process to finalizing a binding agreement in 2009 in Copenhagen.
- The Bali Road Map includes;
 - The Bali Action Plan (BAP)
 - The Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol negotiations and their 2009 deadline,
 - Launch of the Adaptation Fund,
 - Decisions on technology transfer and
 - On reducing emissions from deforestation.

24.3.2. Bali Action Plan

- The Conference of Parties decided to launch a comprehensive process to enable the implementation of the Convention through long-term cooperative action up to and beyond 2012, by addressing:
 - A shared vision for long-term cooperative action, including a long-term global goal for emission reductions.
 - Enhanced national/international action on mitigation of climate change.
 - Enhanced action on adaptation.
 - Enhanced action on technology development and transfer to support action on mitigation and adaptation.

- Enhanced action on the provision of financial resources and investment to support action on mitigation and adaptation and technology cooperation.

24.4. COP 15 COPENHAGEN SUMMIT

- A legally binding agreement could not be arrived n CoP 15, Copenhagen mainly due to discord between developing and developed nations.
- The summit concluded with the CoP taking a note of Copenhagen Accord (a five nation accord-BASIC and US).
- The Copenhagen Accord is a non-binding agreement.
- The Accord states that deep international emissions cuts are needed to hold the increase in global temperature to under two degrees Celsius.
- Under the Accord, developed countries agree to set targets for reductions in their greenhouse gas emissions by 2020.
- Developing countries agree to pursue nationally appropriate mitigation strategies to slow the growth of their emissions, but are not committed to reducing their carbon output.
 - Recognizes the need to establish a mechanism (including REDD-plus) to enable the mobilization of financial resources from developed countries to help achieve this
 - Developing countries, specially these with low-emitting economies should be provided incentives to continue to develop on a low-emission pathway
 - Agrees that developed countries would raise funds of \$30 billion from 2010-2012 of new and additional resources
 - Agrees a "goal" for the world to raise \$100 billion per year by 2020. New multilateral funding for adaptation will be delivered, with a governance structure.



24.5. COP 16 CANCUN SUMMIT

- The Cancun Agreements include decisions under both the Convention and Kyoto protocol negotiating tracks.
- As per the Cancun Agreements, all Parties to the Convention (including the developed and developing countries) have agreed to report their voluntary mitigation goals for implementation.
- These will be subject to measurement and verification or international consultation, as appropriate, in accordance with agreed international guidelines.

24.5.1. Cancun Agreements

- Industrialized country targets are officially recognized under the multilateral process and these countries are to develop low-carbon development plans and strategies and assess how best to meet them, including through market mechanisms, and to report their inventories annually.
- Developing country actions to reduce emissions are officially recognized under the multilateral process. A registry is to be set up to record and match developing country mitigation actions to finance and technology support from by industrialized countries. Developing countries are to publish progress reports every two years.
- A total of \$30 billion in fast start finance from industrialized countries to support climate action in the developing world up to 2012 and the intention to raise \$100 billion in long-term funds by 2020 are included in the decisions.

24.5.2. Mechanism of COP 16

- Three mechanisms that are outcome of CoP 16 are
 1. Technology mechanism
 2. Green climate fund
 3. Adaptation fund

Technology Mechanism

- A Technology Mechanism, under the guidance of and accountable to the Conference of the Parties

(COP), was established by the 16th session of the COP in Cancun 2010.

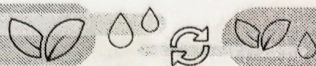
- The Technology Mechanism is expected to facilitate the implementation of enhanced action on technology development and transfer in order to support action on mitigation and adaptation to climate change.

Green Climate Fund

- At COP 16, Parties, established a Green Climate Fund (GCF) as an operating entity of the financial mechanism of the Convention under Article 11.
- The GCF will support projects, programmes, policies and other activities in developing country Parties. The Fund will be governed by the GCF Board.
- The World Bank was invited by the COP to serve as the interim trustee of the GCF, subject to a review three years after operationalization of the Fund.
- The COP also decided that an independent secretariat will support the operations of the Fund. The COP also decided that the GCF was to be designed by the Transitional Committee

Adaptation Fund

- The Adaptation Fund was established to finance concrete adaptation projects and programmes in developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change.
- The Adaptation Fund is financed from the share of proceeds on the clean development mechanism project activities and other sources of funding. The share of proceeds amounts to 2% of certified emission reductions (CERs) issued for a CDM project activity.
- The Adaptation Fund is supervised and managed by the Adaptation Fund Board (AFB). The AFB is composed of 16 members and 16 alternates and meets at least twice a year.
- Upon invitation from Parties, the Global Environment Facility (GEF) provides secretariat



services to the AFB and the World Bank serves as trustee of the Adaptation Fund, both on an interim basis.

24.6. COP 17 DURBAN SUMMIT

New global climate change regime

- India had gone to Durban with two major demands – that the principle of equity remain intact in any new climate regime and that this new global deal be launched after 2020.

Outcome

- New deal to be finalized by 2015 and launched by 2020
- Second phase of Kyoto Protocol secured
- Green Climate Fund launched, though empty as yet Green tech development mechanism put in place
- Equity finds place back in future climate talks

Adaptation mechanism

Transparency mechanism

Secures 10 years of economic growth without carbon containment Intellectual Property Rights and technology not as well anchored in new deal

- Loopholes for developed world not fully blocked
- Agriculture brought in by developed nations under climate change

24.7 DOHA OUTCOMES COP 18, 2012

Global Climate Change Agreement

Governments agreed to work towards a universal climate change agreement by 2015 covering all countries which will come into effect from 2020.

Amendment of the Kyoto Protocol

The Kyoto Protocol is the only existing and binding agreement under which developed countries undertake quantitative commitments to cut greenhouse gases. It was amended so that it could seamlessly continue.

- 8-year second commitment period, which started on January 1st 2013.

- The Kyoto Protocol's Market Mechanisms – the Clean Development Mechanism (CDM), Joint Implementation (JI) and International Emissions Trading (IET) – will continue.
- Access to the mechanisms remains uninterrupted for all developed countries that have accepted targets for the second commitment period.
- A key element was added to the measurement, reporting and verification (MRV) framework for developed countries with the adoption of the tables for the biennial reports known as common tabular format, thereby strengthening transparency and the accountability regime.
- Surplus assigned amount units (AAUs) can be carried over without limit from the first to the second commitment period of the Kyoto Protocol by Parties included in Annex I that have a target for the second commitment period. But there were restrictions on the use of these carried-over AAUs for the second commitment period and quantitative limits on how many of these units may be acquired from other Parties.

Completion of new infrastructure

- In Doha, governments advanced the completion of new infrastructure to channel technology and finance to developing nations and move toward the full implementation of this infrastructure and support.
- Songdo, the Republic of South Korea will be the host of the Green Climate Fund (GCF) and the work plan of the Standing Committee on Finance.
- UNEP-led consortium will be host of the Climate Technology Center (CTC), for an initial term of five years.
- The CTC, along with its associated Network, is the implementing arm of the UNFCCC Technology Mechanism. Governments also agreed the constitution of the Climate Technology Center Network (CTCN) Advisory Board.



24.8 WARSAW OUTCOMES, COP 19, 2013

2015 Agreement

- Governments advanced the timeline for the development of the 2015 agreement.
- Nationally determined contributions would be put forward in a clear and transparent manner.

Closing the pre-2020 ambition gap

- Governments resolved to strengthen measures to close the "ambition gap" – the gap between what has been pledged to date and what is required to keep the world below a maximum average 2 degrees Celsius temperature rise – before the new agreement enters into force in 2020.

Cutting emissions from deforestation – "the Warsaw Framework for REDD+"

- Governments agreed on a set of decisions on ways to reduce emissions from deforestation and forest degradation.
- Global deforestation accounts for some 20 percent of the world's CO₂ emissions. The set of decisions bolsters forest preservation and sustainable use of forests with direct benefits for people who live in and around forests.
- It establishes the means for results-based payments if developing countries can demonstrate the protection of forests.

Progress towards accountability

- The framework for measuring, reporting and verifying mitigation efforts, including by developing countries, is now fully operational. It is an important agreement because it means that the mitigation, sustainability and support efforts of countries can now be better measured.

Technology to boost action on climate change

- CTCN, established in Cancun in 2010, has now moved to the operational stage to support action by developing countries in response to their requests for support through their national designated entities.

- The CTCN is ready to respond to requests from developing countries on issues related to the development and transfer of technology.

24.9 LIMA OUTCOMES, COP 20, 2014

- The Lima Climate Conference achieved "firsts" in the history of the international climate process.
- Pledges were made by both developed and developing countries prior to and during the COP that took the capitalization of the new Green Climate Fund (GCF) past an initial \$10 billion target.
- The Lima Ministerial Declaration on Education and Awareness-raising calls on governments to put climate change into school curricula and climate awareness into national development plans.

Steps Forward on Adaptation

- Progress was made in Lima on elevating adaptation onto the same level as the curbing and cutting of curbing greenhouse gas emissions. This will be done through National Adaptation Plans (NAPs).
- A NAP Global Network was launched involving Peru, the US, Germany, the Philippines, Togo, the UK, Jamaica, and Japan.
- The Lima Adaptation Knowledge initiative--a pilot project in the Andes under the Nairobi Work Programme-- has underlined that establishing the adaptive needs of communities can be successfully captured.
- Countries supported the idea of replicating this in Least Developed Countries, Small Island Developing States and Africa.

More Countries Accept the Kyoto Protocol Doha Amendment

- Nauru and Tuvalu submitted their instrument of acceptance to the Doha amendment, bringing the number of Parties to 21. Acceptance of 144 countries are required to bring it into force.



New climate action portal

- Peru launched a new portal, Nazca Climate Action Portal, with support from the UNFCCC, to increase the visibility of the wealth of climate action among cities, regions, companies and investors, including those under international cooperative initiatives.

Lima Work Programme on Gender

- The Lima conference agreed a Lima Work Programme on Gender to advance gender balance and to promote gender sensitivity in developing and implementing climate policy.

UNFCCC NAMA Day

- A special event took place on actions to reduce emissions with the help of so-called "nationally appropriate mitigation actions" (NAMAs).
- NAMAs are plans of developing countries to reduce emissions and to develop sustainably which can be supported by developed countries. The UNFCCC secretariat has established a registry to match requests for and offers of support.

Climate action on the ground celebrated by the UN

- The UNFCCC secretariat's Momentum for Change Initiative presented awards to representatives of some of the best examples of climate solutions in the world which inspire increased climate action.
- The Momentum for Change initiative this year for the first time included the category of Information and Communication technology.

24.10 PARIS CLIMATE CHANGE CONFERENCE COP 21, 2015

Objectives of the Paris Agreement

- To hold the increase in global average temperature to well below 2 °C above pre industrial levels and
- To pursue efforts to limit temperature increase to 1.5°C above pre-industrial levels, recognizing that

this would significantly reduce the risks and impacts of climate change.

- The Agreement also talks about reaching the global peaking of emissions by the second half of the century, recognizing that peaking will take longer for developing country Parties.

24.10.1. Nationally determined contributions

The Paris Agreement requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

In 2018, Parties will take stock of the collective efforts in relation to progress towards the goal set in the Paris Agreement and to inform the preparation of NDCs.

There will also be a global stock take every 5 years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties.

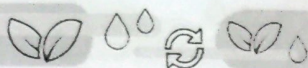
The Paris Agreement entered into force on 4 November 2016. The first session of the Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement (CMA 1) took place in Marrakech, Morocco from 15-18 November 2016.

By the close of the Marrakech conference, it had been ratified by 111 countries representing more than three-fourths of global emissions.

The agreement defines parties' basic obligations and establishes new procedures and mechanisms. But for these to be fully operational, their details must be further elaborated. This requires the adoption by parties of an extensive set of decisions known loosely as the "Paris rulebook."

24.10.2. Article 6

- Article 6 contains three separate mechanisms for "voluntary cooperation" towards climate goals
- Two of the mechanisms are based on markets and a third is based on "non-market approaches".



- Article 6.2 governs bilateral cooperation via “internationally traded mitigation outcomes” (so-called ITMOs), which could include emissions cuts measured in tonnes of CO₂ or kilowatt hours of renewable electricity.
- Article 6.4 will lead to the creation of a new international carbon market for the trade of emissions cuts, created by the public or private sector anywhere in the world.
- Article 6.8 offers a formal framework for climate cooperation between countries, where no trade is involved, such as development aid.

24.11. MARRAKECH CLIMATE CHANGE CONFERENCE –COP22, 2016

Beyond developing the Paris rulebook, parties took actions and made announcements on a range of other issues, including:

Finance

The Paris Agreement requires developed countries to provide biennial reports on financial support provided or mobilized through “public interventions,” and on projected levels of future support. In Marrakech, SBSTA began considering how to account for public finance. Issues include whether the accounting should apply only to flows from developed to developing countries or to broader flows of public finance.

Global Stocktake

In Marrakech, parties began discussing how to structure the stocktake, including its format, inputs, timeline, duration, and output, and its linkage to other elements of the Paris architecture.

“Orphan” issues

One of the most contentious items in Marrakech was how to treat a set of so-called orphan issues that are referenced in the Paris Agreement but not assigned to the APA or another body for further consideration. These issues include whether to establish common timeframes for NDCs (parties adopted different

timeframes in the first round); any rules around the adjustment by parties of their NDCs; and the development of a new collective finance goal beyond 2025. Unable to agree on any specific direction, parties simply asked the APA to continue its consideration of “possible additional matters relating to the implementation of the Paris Agreement.”

Adaptation Fund

One holdover issue from Paris was whether the Adaptation Fund established under the Kyoto Protocol, which provides adaptation support to developing countries, would continue under the Paris Agreement. Although developed countries would prefer to channel support through the newly establish Green Climate Fund, developing countries pushed very hard to keep the Adaptation Fund alive. Parties decided the fund “should serve the Paris Agreement,” pending decisions on governance and other issues.

2018 Facilitative Dialogue

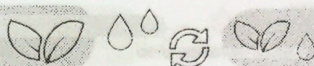
In Paris, anticipating that the Paris Agreement would not be in force for several years, parties decided to conduct an early stocktake through a “facilitative dialogue” in 2018. (The next round of NDCs is due in 2019/20.) In Marrakech, parties asked the presidencies of COP 22 and COP 23 to jointly undertake consultations on how to organize the facilitative dialogue, and to report back at COP 24.

Do you know?

Leadership Group for Industry Transition is a global initiative spearheaded by India and Sweden which gathers countries and companies that are committed to reaching net-zero carbon emissions from industry by 2050.

Mid-century Strategies

The Paris Agreement encourages countries to prepare and submit “long-term low greenhouse gas emission development strategies” outlining the kinds of actions needed to achieve much deeper emission reductions. In Marrakech, Canada, Germany, Mexico, and the



United States became the first countries to submit what have come to be known as mid-century strategies. A new initiative called the 2050 Pathway Platform was launched, with support from a broad array of national governments, cities, states, and companies, to help other countries develop their own mid-century strategies.

Finance

Heading into Marrakech, developed countries released a roadmap outlining how they foresee meeting the goal of mobilizing \$100 billion a year in public and private finance for developing countries by 2020. In Marrakech, the UNFCCC's Standing Committee on Finance released its second biennial assessment, showing that total global climate finance increased 15 percent in 2013-14, reaching a high-bound estimate of \$741 billion in 2014.

Countries and others announced a variety of financial pledges, including:

\$23 million for the Climate Technology Centre and Network (CTCN), which provides technical assistance and capacity building for developing countries.

More than \$50 million for the Capacity-building Initiative for Transparency established in Paris to help developing countries build the capacity to meet new transparency requirements; and

A doubling of World Bank climate finance for the Middle East-North Africa region to \$1.5 billion by 2020.

Loss and Damage

Parties conducted the first review of the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts (WIM). The mechanism, established as an interim body at COP 19 and subsequently brought under the Paris Agreement, is charged with developing approaches to help vulnerable countries cope with unavoidable climate impacts, including extreme weather events and slow-onset events such as sea-level rise. The next review will take place in 2019, and further reviews will be conducted on a five-year cycle, which could align with the global stock takes.

Do you know?

The term loss and damage refer to unavoidable impacts of climate change that cannot be adapted to, from flooded villages to drought-struck farms. It is sometimes framed as climate reparation.

24.12. BONN CLIMATE CHANGE CONFERENCE - COP 23, 2017

Fiji presided over UNFCCC's COP23 in Bonn. COP23 took place in Bonn, Germany in November 2017.

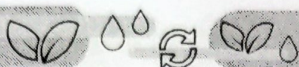
Key outcomes agreed at the UN climate talks in Bonn

The Koronivia Joint Work on Agriculture (KJWA) is a decision that was reached at the COP 23, 2017 on next steps for agriculture within the UNFCCC framework. The decision officially acknowledges the significance of the agriculture sectors in adapting to and mitigating climate change. Under this landmark decision, countries agreed to work together to make sure that agricultural development ensures both increased food security in the face of climate change and a reduction in emissions. The joint work will address six topics related to soils, nutrient use, water, livestock, methods for assessing adaptation, and the socio-economic and food security dimensions of climate change across the agricultural sectors. KJWA is a three-year programme which will finish in Glasgow at COP 26.

Powering Past Coal Alliance

It is launched in COP 23, Bonn and led by UK and Canada. It has more than 20 members aimed at accelerating clean growth and achieving the rapid phase-out of traditional coal power.

Alliance declares that the coal phase-out is required in the OECD and EU 28 by 2030, and no later than by 2050 in the rest of the world" to meet the Paris Agreement. But it does not commit signatories to any particular phase-out date. It also does not commit the



signatories to end the financing of unabated coal power stations, rather just restricting it.

Fiji's COP

Fiji is the first small-island state to host the UNFCCC climate talks.

The outcomes were the

- Gender Action Plan - highlights the role of women in climate action and promotes gender equality in the process.
- Local Communities and Indigenous Peoples Platform - aims to support the exchange of experience and sharing of best practices on mitigation and adaptation.
- Ocean Pathway Partnership - two-track strategy for 2020 supporting the goals of the Paris Agreement that includes; 1. Increasing the role of the ocean considerations in the UNFCCC process and; 2. Significantly increasing action in priority areas impacting or impacted by the ocean and climate change.

Talanoa Dialogue

"Talanoa is a traditional word used in Fiji and across the Pacific to reflect a process of inclusive, participatory and transparent dialogue.

Talanoa Dialogue is a process designed to help countries implement and enhance their Nationally Determined Contributions by 2020. The process of Talanoa involves the sharing of ideas, skills, and experience through storytelling.

It will be structured around three questions – Where are we? Where do we want to go? How do we get there? Originally called the facilitative dialogue, the name was changed to Talanoa dialogue in Bonn UNFCCC meeting under the Fijian COP presidency.

Insu Resilience Global Partnership

The InsuResilience Global Partnership for Climate and Disaster Risk Finance and Insurance Solutions was launched at the UN Climate Conference COP 23 in Bonn.

It brings together G20 countries in partnership with the V20 nations, as well as civil society, international organizations, the private sector, and academia. The V 20 is a group of 49 of the most vulnerable countries including small islands

Its vision is to strengthen the resilience of developing countries and to protect the lives and livelihoods of poor and vulnerable people from the impacts of disasters by enabling faster, more reliable and cost-effective responses to disasters.

It aims to increase the number of poor and vulnerable people in developing countries benefiting from direct or indirect insurance by up to 400 million by 2020.

COP 24

COP 24 took place in December 2018, in Katowice, Poland. Poland held the Presidency of the Climate Convention for the third time.

25.13. COP 25, 2019

- The UN Climate Change Conference COP 25, 2019 took place in Madrid, Spain under the Presidency of the Chile.
- The COP 24 was scheduled to be held at Chile (South America) but due to violent mass movement across the country, the cop 25 took place in Madrid, Spain.
- The ambition of cop 25 was to complete the rulebook to the 2015 Paris Agreement. The rule book will become effective in 2020 and replace the 1997 Kyoto Protocol which comes to an end in 2020.
- But Countries failed to agree on many of the hoped-for outcomes, including rules to set up a global carbon trading system and a system to channel new finance (loss and damage) to countries facing the impacts of climate change in COP 25.
- And it was planned to take forward in 2020 and as due to covid 19 the COP 26 is postponed to 2021 November, completion rule book for Paris agreement is expected to take place in 2021.



Major outcomes

- The Paris Agreement is clear on double counting of carbon credits that a country that sells emissions cuts via offsetting credits to another country can not count those emissions cuts towards its own climate targets. The agreement is yet to be reached as Australia, Brazil and few others are not in agreement.
- A new five-year gender action plan (which was originally agreed in COP 20 Lima) intended to "support the implementation of gender-related decisions and mandates in the UNFCCC process".
- Climate Ambition Alliance (CAA) is led by Chile which launched at climate action summit, New York 2019. 73 countries joined the alliance at the COP 25. The main purpose of the alliance is to upscale 2020 targets of members of UN and to achieve Net Zero Carbon Emissions by 2050. The alliance will focus on resilience in infrastructure, management of water and sustainability of cities. The alliance will focus on Nationally Determined Contributions in order to achieve Net Zero by 2050. EU agreed to a "climate neutral" target for 2050, joining CAA.

4. GLASGOW COP 26 OUTCOMES

- Countries to revisit and strengthen their climate pledges by the end of 2022
- Calls for a "phasedown" of coal and phase out of inefficient fossil fuel subsidy
- Sets up processes towards delivering a global goal on adaptation, higher levels of climate finance and finance for loss and damage.
- Rich nations failed to meet the \$100bn annual climate finance target for 2020. The pact "urges" them to meet the target "urgently and through to 2025".
- Regarding streamlining the timeframe for INDC, the pact encourages all parties to communicate about their INDC with the end date of 2035, in 2025 and in 2030 about their INDC with an end date of 2040, and so forth every five years thereafter.

- Global stocktake – COP of UNFCCC will do an assessment of mitigation, adaptation and the "means of implementation and support", such as finance periodically. First stocktake is set to take place in 2023

Deforestation pledges

1. Declaration of forest and land use signed by more than 130 countries promising to work collectively to halt and reverse forest loss and land degradation by 2030.
2. Forest, Agriculture and commodity trade jointly led by the UK and Indonesia. It aims to support sustainable trade between commodity producing countries and consuming countries.

Global Methane pledge

- Led by US and European Commission the pledge asks countries to cut their methane emission by 30% over 2020-30.

Global coal to clean power transition statement

- 23 nations committed to phase out and not build or invest in new coal power domestically and internationally.

Accelerating the transition to 100% zero-emission cars and vans

- Not legally binding, the coalition of countries, cities, car manufacturers and other organizations said they will "work towards all sales of new cars and vans being zero emission globally by 2040 and by no later than 2035 in leading markets."

Glasgow financial alliance for Net Zero (GFANZ)

- Had committed \$130tn towards the net-zero transition.
- Under the terms of GFANZ (450 firms in 45 countries) signatories must commit to use "science-based guidelines" to reach net-zero carbon emissions by 2050 and to provide 2030 interim goals.

Beyond oil and gas alliance

- Seeks to deliver a managed and just transition away from oil and gas production



- Led by the governments of Denmark and Costa Rica, the coalition includes France, Greenland, Ireland, Quebec, Sweden and Wales as core members.

Article 6 (refer COP 21)

- Regarding Article 6 rules of Paris agreement (for carbon markets and voluntary international cooperation) the rules are agreed in Glasgow.
- Parties agreed to the carryover of carbon credits generated under the Kyoto Protocol since 2013, bringing upto 320 m tonnes of CO₂ equivalent (MtCO₂e) into the Paris mechanism.
- Closed the double counting / double claiming of carbon emission cuts.
- Excluded the use of credits generated historically from avoided deforestation.

24.15. SHARM EL-SHEIKH COP 27 OUTCOMES

Major outcomes:

- The United Nations Climate Change Conference COP27 has agreed to establish a “Loss and Damage” fund to provide financial assistance to countries vulnerable to climate-related losses. At COP27, a new five-year work program was introduced to promote climate technology solutions in developing nations.
- In the realm of mitigation, a work program has been initiated with the goal of rapidly increasing efforts to mitigate climate change. This program will commence immediately after COP27 and extend until 2030, featuring at least two global dialogues each year. Governments have also been urged to review and strengthen their 2030 climate targets within their national plans by the end of 2023, alongside accelerating efforts to reduce coal power and phase out inefficient fossil fuel subsidies.
- Delegates at COP27 have wrapped up the second technical dialogue of the inaugural global stocktake, a mechanism aimed at raising climate

ambition as per the Paris Agreement. Prior to the stocktake's conclusion at COP28 the following year, a 'climate ambition summit' will be convened in 2023 by the UN Secretary-General.

- The Sharm-El-Sheikh Adaptation Agenda outlines 30 Adaptation Outcomes to bolster resilience for the 4 billion people living in the most climate-vulnerable communities by 2030.
- The Action on Water Adaptation and Resilience Initiative (AWARe) has been launched to address the significance of water in both climate change challenges and solutions.
- The African Carbon Market Initiative (ACMI) has been introduced to support carbon credit production and job creation in Africa.
- Global Renewables Alliance has been established, bringing together all the necessary technologies for the energy transition, with the aim of not only achieving targets but also positioning renewable energy as a pillar of sustainable development and economic growth.

24.16. OTHER MECHANISMS OF UN

1. Special Climate Change Fund (Sccf)

- The Special Climate Change Fund (SCCF) was established under the Convention in 2001 to finance projects relating to: adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification.
- The Global Environment Facility (GEF), as an operating entity of the financial mechanism, has been entrusted to operate the SCCF.

2. Finance Mechanism for Climate Change

- The Financial resources that have been made available to Non-Annex I Parties to the UNFCCC consist of the following three modules:
 - **The “National Communications Module”:** This module presents information communicated by Annex II Parties on the provision of financial resources related to the



implementation of the Convention through their fourth and fifth national communications.

Fast-Start Finance

- During the Conference of the Parties (COP15) held in December 2009 in Copenhagen developed countries pledged to provide new and additional resources, including forestry and investments, approaching USD 30 billion for the period 2010 - 2012 and with balanced allocation between mitigation and adaptation. This collective commitment has come to be known as 'fast-start finance'.

- Following up on this pledge, the Conference of the Parties (COP 16) in Cancún, in December 2010, took note of this collective commitment by developed country Parties and reaffirmed that funding for adaptation will be prioritized for the most vulnerable developing countries, such as the least developed countries, small island developing States and Africa.

At COP 17 Parties welcomed the fast-start finance provided by developed countries as part of their collective commitment to provide new and additional resources approaching USD 30 billion for the period 2010-2012, and noted the information provided by developed country Parties on the fast-start finance they have provided and urged them to continue to enhance the transparency of their reporting on the fulfillment of their fast-start finance commitments.

- **The "Funds Managed by the GEF Module"** is a joint effort between the secretariat of the UNFCCC and the secretariat of the Global Environment Facility (GEF). This module presents information on financial flows that have been channelled, mobilized and leveraged by the GEF in its role as an operating entity of the Financial Mechanism of the UNFCCC.

24.17. REDD & REDD+

- REDD (Reducing Emissions from Deforestation and Forest Degradation) is the global endeavour to create an incentive for developing countries to protect, better manage and save their forest resources, thus contributing to the global fight against climate change
- REDD+ goes beyond merely checking deforestation and forest degradation, and includes incentives for positive elements of conservation, sustainable management of forests and enhancement of forest carbon stocks.
- REDD+ conceptualizes flow of positive incentives for demonstrated reduction in deforestation or for enhancing quality and expanse of forest cover.
- It works on the basis of creating a financial value for the carbon stored and enhanced in biomass and soil of standing forests. Countries that reduce emissions and undertake sustainable management of forests will be entitled to receive funds and resources as incentives.
- REDD+ approach incorporates important benefits of livelihoods improvement, biodiversity conservation and food security services.

Will India Benefit from REDD+?

India's sustained efforts for conserving and expanding its forest and tree resources have the possibility of being rewarded for providing carbon service to the international community in addition to providing traditional goods and services to the local communities.

- The incentives so received from REDD+ would be passed to the local communities involved in protection and management of the forests. This will ensure sustained protection of our forests against deforestation.



- It is estimated that a REDD+ programme for India could provide capture of more than 1 billion tonnes of additional CO₂ over the next 3 decades and provide more than USD 3 billion as carbon service incentives under REDD+.

India's Position on Redd And Redd+

- India believes REDD needs to be seen in the broader context of REDD+, not in isolation or in a truncated form since reduction of deforestation, and conservation and improvement of forests are two sides of the same coin, and so should be treated at par.
- India's stand was finally accepted in 13th Meeting of the Conference of the Parties (COP 13) at Bali when elements of conservation, sustainable management of forests and enhancement of forest carbon stocks were added to the then existing text of reducing deforestation and forest degradation as part of Bali Action Plan.
- It has presented an ambitious Green India Mission programme under its National Action Plan on Climate Change.

India initiatives related to REDD+

- India has made a submission to 'UNFCCC on "REDD, Sustainable Management of Forest(SMF) and Afforestation and Reforestation (A&R)" in December 2008
- A Technical Group has been set up to develop methodologies and procedures to assess and
- monitor contribution of REDD+ actions
- A National REDD+ Coordinating Agency is being established
- A National Forest Carbon Accounting Programme is being institutionalized
- India is hosting the Conference of Parties (COP-11) of the Convention on Biological Diversity (CBD) in 2012, to coincide with twenty years of Rio convention.
- Study on the impact of climate change on India's forests assigned to the Indian Network for Climate Change Assessment (INCCA), has been released in November 2010.

- There is likely to be an increase in Net Primary Productivity (NPP) ranging from 20 - 57 %.

India looks for Enhanced Implementation of the Unfccc

India looks forward to enhanced international cooperation under the UNFCCC. Overall, future international cooperation on climate change should address the following objectives:

- Minimizing the negative impacts of climate change through suitable adaptation measures in the countries and communities affected and mitigation at the global level
- Provide fairness and equity in the actions and measures
- Uphold the principle of common but differentiated responsibilities in actions to be taken, such as concessional financial flows from the developed countries, and access to technology on affordable terms
- India as a large democracy, with the major challenge of achieving economic and social development and eradicating poverty, will engage in negotiations and other actions at the international level in the coming months that would lead to efficient and equitable solutions at the global level.

24.18. THE GEF

- Article 11 of the UNFCCC creates a 'financial mechanism' for convention implementation, which is to function under the guidance of the UNFCCC COP and be accountable to the COP.
- Under Article 11(1), the COP is to decide on the financial mechanism's policies, programme priorities and eligibility criteria relating to the convention.
- Article 21 names the GEF to serve as the financial mechanism on an interim basis.
- The GEF was established in 1991 by the World Bank in consultation with the United Nations Development Programme (UNDP) and the United

Nations Environment Programme (UNEP), to provide funding to protect the global environment.

- The GEF's governance, operational, financial and administrative oversight procedures are set out in the Instrument for the Establishment of the Restructured Global Environment Facility, which was adopted in 1994 and subsequently amended in 2002 (GEF Instrument).

- The GEF now has six focal areas:

1. biological diversity;
2. climate change;
3. international waters;
4. land degradation, primarily desertification and deforestation;
5. ozone layer depletion; and
6. persistent organic pollutants.

19. CLIMATE-SMART AGRICULTURE

While agriculture is the sector most vulnerable to climate change, it is also a major cause, directly accounting for about 14 percent of greenhouse gas emissions (IPCC 2007).

- And yet, agriculture can be a part of the solution: helping people to feed themselves and adapt to changing conditions while mitigating climate change.
- It is possible for agriculture to actually sequester or absorb carbon into the soil rather than emitting it. This can be done without the trade off with productivity and yields.
- It is possible to have higher yields, more carbon in the soil and greater resilience to droughts and heat.
- This is called the 'triple win': interventions that would increase yields (poverty reduction and food security), make yields more resilient in the face of extremes (adaptation), and make the farm a solution to the climate change problem rather than part of the problem (mitigation).
- These triple wins are likely to require a package of interventions and be country- and locality specific in their application. This method of

practicing agriculture is called 'Climate Smart Agriculture'.

24.19.1 Climate-smart agriculture includes proven practical techniques.

For example,

- by increasing the organic content of the soil through conservation tillage, its water holding capacity increases, making yields more resilient and reducing erosion.
- Promoting soil carbon capture also helps mitigate climate change. Another example is integrated soil fertility management that can lower fertilizer costs, increase soil carbon and improve yields.
- Climate-smart agriculture gives attention to landscape approaches, for example, integrated planning of land, agriculture, forests, fisheries and water to ensure synergies are captured.

- These can be further strengthened by adding better weather forecasting, more resilient food crops and risk insurance to cover losses when the vagaries of weather strike.
- If yields increase through such practices and become more stable, it results in improved farm incomes. A more stable income helps enhance the adaptive capacity of farmers.
- A good number of countries are now showing that it can be done.
- China has been a leader in this, with programs such as the Loess Plateau now internationally famous.
- Brazil has also invested in good quality research and extension and is demonstrating these triple results.
- And small-holder farmers in Kenya are already receiving cash payments on a pilot basis for new farming techniques that will hold more carbon in the soil, even while increasing soil fertility.

24.20. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

- The UN General Assembly adopted a resolution, in December 1988, on the subject and endorsed the



UNEP/WMO proposal for the setting up of the Inter-Governmental Panel on Climate Change (IPCC).

- It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the governments of the world with a clear scientific view of what is happening to the world's climate.
- The Secretariat coordinates all the IPCC work and liaises with Governments. The secretariat is supported by WMO and UNEP and hosted at WMO headquarters in Geneva.
- It is open to all member countries of the United Nations (UN) and WMO. Currently 195 countries are members of the IPCC.
- The initial task for the IPCC as outlined in the UN General Assembly Resolution 1988 was to prepare a comprehensive review and recommendations with respect to the state of knowledge of the science of climate change; social and economic impact of climate change, and possible response strategies and elements for inclusion in a possible future international convention on climate.
- The IPCC is a scientific body. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change.
- It does not conduct any research nor does it monitor climate related data or parameters.
- Thousands of scientists from all over the world contribute to the work of the IPCC on a voluntary basis.
- Review is an essential part of the IPCC process, to ensure an objective and complete assessment of current information.
- Governments participate in the review process and the plenary Sessions, where main decisions about the IPCC work programme are taken and reports are accepted, adopted and approved.
- By endorsing the IPCC reports, governments acknowledge the authority of their scientific

content. The work of the organization is therefore policy-relevant and yet policy-neutral, never policy-prescriptive.

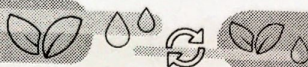
- The IPCC has delivered on a regular basis the most comprehensive scientific reports about climate change produced worldwide, the Assessment Reports.
- It has also responded to the need of the UNFCCC for information on scientific and technical matters through Special Reports, Technical Papers and Methodology Reports.
- It has also produced methodologies and guidelines to help Parties to the UNFCCC prepare their national greenhouse gas inventories.

24.20.1. Assessment Reports

- In accordance with its mandate and as reaffirmed in various decisions by the Panel, the IPCC prepares at regular intervals comprehensive Assessment Reports of scientific, technical and socio-economic information relevant for the understanding of human induced climate change, potential impacts of climate change and options for mitigation and adaptation.
- Assessment Reports are normally published in several volumes, one for each of the Working Groups of the IPCC and, subject to the decision by the Panel, a Synthesis Report.
- They are written in a non-technical style suitable for policymakers. They are composed of a longer report and a Summary for Policymakers.
- Five Assessment Reports have been completed in 1990, 1995, 2001 and 2007, 2014.

AR5 Contents

- Compared with previous reports, the AR5 has put greater emphasis on assessing the socio-economic aspects of climate change and implications for sustainable development, risk management and the framing of a response through both adaptation and mitigation.
- The AR5 comprise the full reports prepared by the Working Groups (I, II and III) as well as the Synthesis Report.



- Key AR5 cross-cutting themes are:
 - Water and the Earth System: Changes, Impacts and Responses;
 - Carbon Cycle including Ocean Acidification;
 - Ice Sheets and Sea-Level Rise;
 - Mitigation, Adaptation and Sustainable Development; and
 - Article 2 of the UNFCCC (see UNFCCC for definition).

Special Reports

- Special Reports have been prepared on topics such as aviation, regional impacts of climate change, technology transfer, emissions scenarios, land use, land use change and forestry, carbon dioxide capture and storage and on the relationship between safeguarding the ozone layer and the global climate system.

The IPCC released the third part of the Sixth Assessment Report (AR6), titled 'Climate Change 2022: Mitigation of Climate Change', the Working Group III contribution to the Sixth Assessment Report.

- The previously released reports in AR 6 were the report of Working Group I- 'Climate Change 2021: The Physical Science Basis (August 2021) and Report of Working Group II-'Climate Change 2022: Impacts, Adaptation and Vulnerability' (February 2022).
- It focuses on the themes of global assessment of climate change mitigation progress and pledges and the sources of global emissions. Synthesis report of AR 6 would be completed by 2024.

24.21. NATIONAL GREEN HOUSE GAS INVENTORIES PROGRAMME (NGGIP)

- The IPCC established the national green house gas Inventories Programme (NGGIP) to provide

methods for estimating national inventories of greenhouse gas emissions to, and removals from, the atmosphere.

- The guidance produced by the NGGIP is used by countries that are Parties to the UN Framework Convention on Climate Change (UNFCCC) to estimate the emissions and removals that they report to the UNFCCC.
- It may be used by others who want to produce estimates consistent with national totals. Internationally agreed guidance is needed so that emission and removal estimates can be compared between countries and over time.
- All the IPCC guidance has therefore been compiled by an international range of authors and with an extensive global review process.

24.21.1. Methodology

- The first methodologies were produced by the IPCC in early 1990s and have been revised since (Development of IPCC Guidelines and Good Practice Guidance).
- The Revised 1996 Guidelines for National Greenhouse Gas Inventories, the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG2000) and the Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF) are used by developed countries to estimate emissions and removals, and are recommended by the UNFCCC for use by all countries.
- The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (the 2006 Guidelines) are the IPCC's most recent guidance on methods and data for developing estimates of emissions and removals of greenhouse gases.
- They build on earlier guidance, over a decade of experience and a world-wide scientific and technical effort to produce guidelines, applicable to all countries notwithstanding widely varying levels of resources and expertise.



Mandate

- The current mandate of the National Greenhouse Gas Inventories Programme (NGGIP) was approved by IPCC16 (Montreal, May 2000). IPCC19 (Geneva, April 2002) decided to maintain its Task Force on Inventories, co-chaired by two members of the IPCC Bureau (one from an industrialized country and one from a developing country) with twelve additional members on the Task Force Bureau (two per IPCC/WMO region).
- The NGGIP is mandated to carry out the work, as approved by the Panel, on inventory-related methodologies and practices.

24.21.2. The Panel decided:

- That the IPCC is responsible for assessing and developing inventory methods and practices which are scientifically sound and relevant to all countries, noting particularly the lack of information in developing countries.
- This includes
 - (a) developing methods for estimating emissions of greenhouse gases (GHGs) by sources and removals by sinks,
 - (b) assessing and developing methods to quantify and to manage uncertainties in the estimates of GHGs,
 - (c) assessing the scientific literature related to the development of GHG emission factors and management of inventories,
 - (d) disseminating information related to inventory methods and practices,
 - (e) identifying the implications of the different options in relation to inventory methods and practices and
 - (f) assessing scientific issues related to independent verification.

24.22. GREEN ECONOMY

- The concept of green economy lacks an internationally agreed definition or universal principles. The Rio + 20 outcome document identifies green economy in the context of sustainable development and poverty eradication and it affirms that approach will be different in accordance with the national circumstances and priorities for each country.
- Accordingly, green economy in India is seen in the context of sustainable development and inclusive economic growth including poverty eradication. The Government endeavors to address all the three dimensions of sustainable development (social, economic and environmental) in a balanced manner.
- Green economy focuses specifically on the fundamental changes that are required to ensure that economic systems are made more sustainable. Green Economy focuses on the ways to overcome the deeply rooted causes of unsustainable economic development.
- A Green Economy is one whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystems.
- The Green Economy is about sustainable energy, green jobs, low carbon economies, green policies, green buildings, agriculture, fisheries, forestry, industry, energy efficiency, sustainable tourism, sustainable transport, waste management, water efficiency and all other resource efficiency.

24.22.1. Transition to green economy

Three priorities in transition of economy to green economy are

- decarbonizes the economy;
- commit the environmental community to justice and equity; and
- conserve the biosphere.



A key step forward consists in changing our conception of growth and prosperity – achieving more with less and creating real wealth and quality of life.

24.22.2. Measures to adapt green economy

- Energy audit can reduce your building's climate footprint and lead to significant savings in energy costs.
- Overfishing in many parts of the world threatens to deplete future fish stocks. We can avoid this by working to promote sustainable fishing practices.
- Deforestation accounts for close to 20% of the world's greenhouse gas emissions.
- Sustainably managed forests can continue to support communities and ecosystems without damaging environment and climate.

Use electronic files to reduce your demand for paper products.

When you support certified sustainable forest products, you support a healthy environment and sustainable livelihoods.

- Car-pooling or taking public transport reduces environmental impacts and economic costs while strengthening community.
- Walking or riding a bike for short trips is good for your health - and the environment.
- Taking small steps towards wise water use can help conserve this precious resource
- Resource efficiency is key to a Green Economy and water is one of our most important resources.
- The development of clean, renewable energy by using solar, wind, tidal, etc will contribute to green economy.
- Recycling appropriate materials and composting food waste reduces the demand on our natural resources.
- Moving towards a green economy has the potential to achieve sustainable development and eradicate poverty on an unprecedented scale, with speed and effectiveness.

24.23. GLOBAL CLIMATE FINANCE ARCHITECTURE

The global climate finance architecture is channeled through multilateral funds such as the Global Environment Facility and the Climate Investment Funds and as well as increasingly through bilateral channels.

Strategic Climate Fund

- Administered by the World Bank
- Area of focus - Adaptation, Mitigation - general, Mitigation - REDD
- Date operational - 2008
- The Strategic Climate Fund (SCF), one of two multi-donor Trust Funds within the Climate Investment Funds (CIFs), serves as an overarching framework for three targeted programs piloting new approaches and scaled-up, transformational action on climate change:

1. Forest Investment Program (FIP);
2. Pilot Program for Climate Resilience (PPCR); and
3. Scaling Up Renewable Energy in Low Income Countries Program (SREP).

Forest Investment Program

- Administered by The World Bank
- Area of focus - Mitigation - REDD
- Date operational - 2009

The Forest Investment Program (FIP) is a targeted program of the Strategic Climate Fund (SCF) within the Climate Investment Funds (CIF).

The FIP supports developing countries' efforts to reduce deforestation and forest degradation (REDD) and promotes sustainable forest management that leads to emission reductions and the protection of carbon reservoirs.

It achieves this by providing scaled-up financing to developing countries for readiness reforms and public and private investments, identified through national REDD readiness or equivalent strategies.



Pilot Program for Climate Resilience

- Administered by The World Bank
- Area of focus - Adaptation
- Date operational - 2008

The Pilot Program for Climate Resilience (PPCR) is a targeted program of the Strategic Climate Fund (SCF), which is one of two funds within the Climate Investment Funds (CIF) framework.

The PPCR aims to pilot and demonstrate ways in which climate risk and resilience may be integrated into core development planning and implementation by providing incentives for scaled-up action and initiating transformational change.

Scaling-Up Renewable Energy Program for Low Income Countries

- Administered by The World Bank
- Area of focus - Mitigation - general
- Date operational - 2009

The Scaling-Up Renewable Energy Program in Low Income Countries (SREP) is a targeted program of the Strategic Climate Fund (SCF), which is one of two funds within the Climate Investment Funds (CIF) framework.

The SREP was designed to demonstrate the economic, social and environmental viability of low carbon development pathways in the energy sector in low-income countries.

It aims to help low-income countries use new economic opportunities to increase energy access through renewable energy use.

Biocarbon Fund

- Administered by The World Bank
- Area of focus - Adaptation, Mitigation - general, Mitigation - REDD
- Date operational - 2004

The BioCarbon Fund Initiative for Sustainable Forest Landscapes supports developing countries' efforts to reduce emission through testing jurisdictional approaches that integrate reducing deforestation and

degradation, sustainable forest management with the climate smart agricultural practices to green supply chains.

Clean Technology Fund

- Administered by The World Bank
- Area of focus - Mitigation - general
- Date operational - 2008

The Clean Technology Fund (CTF), one of two multi-donor Trust Funds within the Climate Investment Funds (CIFs), promotes scaled-up financing for demonstration, deployment and transfer of low-carbon technologies with significant potential for long-term greenhouse gas emissions savings.

Channelled through the African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank, and World Bank Group, the CTF finances 12 country programmes and one regional programme.

Forest Carbon Partnership Facility

- Administered by The World Bank
- Area of focus - Mitigation - REDD
- Date operational - 2008

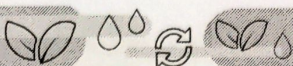
The Forest Carbon Partnership Facility (FCPF) is a World Bank programme and consists of a Readiness Fund and a Carbon Fund.

The FCPF was created to assist developing countries to reduce emissions from deforestation and forest degradation, enhance and conserve forest carbon stocks, and sustainably manage forests (REDD+).

Partnership for Market Readiness

- Administered by The World Bank
- Area of focus - Mitigation - general
- Date operational - 2011

It is a partnership of developed and developing countries administered by the World Bank, established to use market instruments to scale up mitigation efforts in middle income countries.



Although initially geared towards promoting market readiness for the anticipated emergence of international carbon markets, this approach has become more flexible, providing grants and technical support for proposals for implementation of market tools that contribute to mitigation efforts.

Special Climate Change Fund

- Administered by The Global Environment Facility (GEF)
- Area of focus - Adaptation
- Date operational - 2002

The Special Climate Change Fund (SCCF) was created in 2001 to address the specific needs of developing countries under the UNFCCC. It covers the incremental costs of interventions to address climate change relative to a development baseline.

Adaptation to climate change is the top priority of the SCCF, although it can also support technology transfer and its associated capacity building activities.

The SCCF is intended to catalyse and leverage additional finance from bilateral and multilateral sources, and is administered by the Global Environment Facility.

Strategic Priority on Adaptation

- Administered by the Global Environment Facility (GEF)
- Area of focus - Adaptation
- Date operational - 2004

The Strategic Priority on Adaptation (SPA) was a 3-year pilot programme aimed to show how adaptation planning and assessment could be practically translated into full-scale projects.

The Fund is now closed.

The SPA overall objective was to address local adaptation needs and generate global environmental benefits in the focal areas in which the GEF works: biodiversity, climate change, international waters, land degradation, and persistent organic pollutants.

GEF Trust Fund - Climate Change focal area

- Administered by The Global Environment Facility (GEF)
- Area of focus - Adaptation, Mitigation - general
- Date operational - 1991 (tracked since 2010)

The Global Environment Facility Trust Fund supports the implementation of multilateral environmental agreements, and serves as a financial mechanism of the UN Framework Convention on Climate Change.

It is the longest standing dedicated public climate change fund. Climate Change is one of the six focal areas supported by the GEF Trust Fund.

The GEF also administers several funds established under the UNFCCC including the Least Developed Countries Trust Fund (LDCF), the Special Climate Change Trust Fund (SCCF) and is interim secretariat for the Adaptation Fund.

Least Developed Countries Fund

- Administered by The Global Environment Facility (GEF)
- Area of focus - Adaptation
- Date operational - 2002

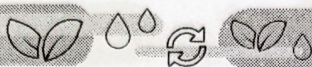
The Least Developed Countries Fund (LDCF) was established to meet the adaptation needs of least developed countries (LDCs).

Specifically the LDCF has financed the preparation and implementation of National Adaptation Programs of Action (NAPAs) to identify priority adaptation actions for a country based on existing information.

Green Climate Fund

- Administered by - to be confirmed
- Area of focus - Adaptation, Mitigation - general, Mitigation - REDD
- Date operational - 2015

The Green Climate Fund (GCF) was adopted as a financial mechanism of the UN Framework Convention on Climate Change (UNFCCC) at the end of 2011.



It aims to make an ambitious contribution to attaining the mitigation and adaptation goals of the international community.

Over time it is expected to become the main multilateral financing mechanism to support climate action in developing countries.

Adaptation Fund

- Administered by Adaptation Fund Board
- Area of focus - Adaptation
- Date operational - 2009

The Adaptation Fund is a financial instrument under the UNFCCC and its Kyoto Protocol (KP) and has been established to finance concrete adaptation projects and programmes in developing country Parties to the KP, in an effort to reduce the adverse effects of climate change facing communities, countries and sectors.

The Fund is financed with a share of proceeds from Clean Development Mechanism (CDM) project activities as well as through voluntary pledges of donor governments.

The share of proceeds from the CDM amounts to 2% of Certified Emission Reductions (CERs) issued for a CDM project activity.

Global Climate Change Alliance

- Administered by The European Commission
- Area of focus - Adaptation, Mitigation - general, Mitigation - REDD
- Date operational - 2008

The Global Climate Change Alliance (GCCA) is an initiative of the European Union.

Its overall objective is to build a new alliance on climate change between the European Union and the poor developing countries that are most affected and that have the least capacity to deal with climate change.

The GCCA does not intend to set up a new fund or governance structure, but is working through the European Commission's established channels for

political dialogue and cooperation at national and international level.

Global Energy Efficiency and Renewable Energy Fund

- Administered by The European Commission
- Area of focus - Mitigation - general
- Date operational - 2008

The Global Energy Efficiency and Renewable Energy Fund (GEEREF) is a Public-Private Partnership (PPP) designed to maximise the private finance leveraged through public funds funded by the European Commission and managed by the European Investment Bank.

GEEREF is structured as a fund of funds, and invests in private equity sub-funds that specialise in financing small and medium-sized project developers and enterprises (SMEs) to implement energy efficiency and renewable energy projects in developing countries and economies in transition.

MDG Achievement Fund - Environment Climate Change thematic window

- Administered by UNDP
- Area of focus - Adaptation, Mitigation - general
- Date operational - 2007

The MDG Achievement Fund (MDG-F) was established by the Government of Spain and the United Nations Development Programme (UNDP) to accelerate efforts to reach the Millennium Development Goals.

Environment and Climate Change is one of eight thematic areas supported by the MDG-F.

The objective of this part of the fund is to help reduce poverty and vulnerability in eligible countries by supporting interventions that improve environmental management and service delivery at the national and local level, increase access to new financing mechanisms and enhance capacity to adapt to climate change.



This part of the fund is now closed, although finance for approved projects is still being disbursed and monitored by CFU.

UN-REDD Programme

- Administered by UNDP
- Area of focus - Mitigation - REDD
- Date operational - 2008

Three UN Agencies - United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP) and Food and Agriculture Organization of the United Nations (FAO) - have collaborated in the establishment of the UN-REDD programme, a multi-donor trust fund that allows donors to pool resources and provide funding with the aim of significantly reducing global emissions from deforestation and forest degradation in developing countries.

Through its nine initial country programme activities in Africa, Asia and Latin America, the UN-REDD Programme supports the capacity of national governments to prepare and implement national REDD strategies with the involvement of all stakeholders.

Adaptation for Smallholder Agriculture Program

Administered by the International Fund for Agricultural Development

- Area of focus - Adaptation
- Date operational - 2012

To channel climate and environmental finance to smallholder farmers, scale up climate change adaptation in rural development programmes and mainstream climate adaptation into IFAD's work.

Amazon Fund (Fundo Amazônia)

- Administered by Brazilian Development Bank (BNDES)
- Area of focus - Mitigation - REDD
- Date operational - 2009

The Amazon Fund was created to raise donations so that investments can be made in efforts to prevent, monitor and combat deforestation, as well as to promote the conservation and sustainable use of forests in the Amazon Biome.

Although the Amazon Fund was created by the government and is managed by a public bank, it is a private fund.

Congo Basin Forest Fund

- Administered by African Development Bank
- Area of focus - Mitigation - REDD
- Date operational - 2008

The Congo Basin Forest Fund (CBFF) is a multi-donor fund set up in June 2008 to take early action to protect the forests in the Congo Basin region.

It aims to support transformative and innovative projects to be complemented to existing activities, which will develop the capacity of people and institutions of the Congo Basin to enable them to preserve and manage their forests.

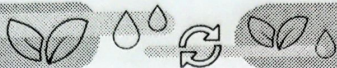
It provides a source of accessible funding, and encourages governments, civil society, NGOs and the private sector to work together to share specific expertise.

Do you know?

Earth Overshoot Day is the Calendar date on which human resource consumption for that particular year exceeds Earth's capacity to regenerate those resources required for the human consumption for the entire year. It is calculated by Global Footprint Network, an independent think tank.

Indonesia Climate Change Trust Fund

- Administered by Indonesia's National Development Planning Agency
- Area of focus - Adaptation, Mitigation - general, Mitigation - REDD
- Date operational - 2010



The Indonesia Climate Change Trust Fund (ICCTF) is a national funding entity which aims to develop innovative ways to link international finance sources with national investment strategies.

Created by the Government of Indonesia (GOI), it acts as a catalyst to attract investment and to implement a range of alternative financing mechanisms for climate change mitigation and adaptation programmes.

The ICCTF receives non-refundable contributions from bilateral and multilateral donors.

The main funding mechanism of the ICCTF is the 'Innovation Fund', which provides grants to line ministries to support climate change related projects within the GOI.

One Planet Summit

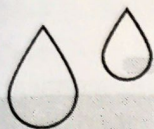
- At least 50 countries committed to protecting 30% of the planet, including land and sea, over the next decade to halt species extinction and address climate change issues, aimed at protecting the world's biodiversity.
- The summit launched a program called PREZODE an international initiative to prevent the emergence of zoonotic diseases and pandemics.

Petersberg Climate Dialogue

Petersberg Climate Dialogue which has been hosted by Germany since 2010 to provide a forum for informal high-level political discussions, focusing both on international climate negotiations and the advancement of climate action.

The virtual XI Petersberg Climate Dialogue was co-chaired by Germany and United Kingdom, the incoming Presidency of 26th Conference of Parties (COP 26) to United Nations Framework Convention on Climate Change (UNFCCC). The dialogue saw participation from Ministers and representatives of about 30 countries.

This year's dialogue came at a crucial juncture when countries are tackling the COVID-19 pandemic to save lives, overcoming social and economic consequences of the pandemic while also preparing to move into the implementation phase of Paris Agreement under UNFCCC in post-2020 period. The key agenda of the dialogue was to discuss how we can jointly tackle the challenge of reinvigorating our economies and societies after COVID-19, while enhancing our resilience and catalyzing climate action while also supporting in particular those most vulnerable.



CHAPTER - 25



AGRICULTURE

**"A man without food
For three days will quarrel,
For a week will fight and
For a month or so will die"**

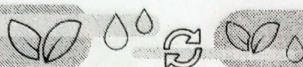
25.1. AGRICULTURE

- The term agriculture is derived from two Latin words ager or agri meaning soil and cultura meaning cultivation. Agriculture is a broad term encompassing all aspects of crop production, livestock farming, fisheries, forestry etc.
- Silviculture is the art of cultivating forest trees.
- Sericulture is the rearing of silkworms for the production of raw silk.
- Apiculture is the maintenance of honey bee colonies, commonly in hives, by humans
- Olericulture is the science of vegetable growing, dealing with the culture of non-woody (herbaceous) plants for food.
- Viticulture is the science, production and study of grapes
- Floriculture is a discipline of horticulture concerned with the cultivation of flowering and ornamental plants for gardens
- Arboriculture is the cultivation, management, and study of individual trees, shrubs, vines, and other perennial woody plants

- Pomology is a branch of horticulture which focuses on the cultivation, production, harvest, and storage of fruit, etc.
- Aeroponics is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium
- Hydroponics is a method of growing plants using mineral nutrient solutions, in water, without soil.
- Terrestrial plants may also be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel, mineral wool, expanded clay or coconut husk.
- Geoponic in farming practice, refers to growing plants in normal soil

25.1.1. Scope and Importance of Agriculture

- With a 18.3 per cent contribution to the gross domestic product (GDP), agriculture provides livelihood support to about two-thirds of country's population.
- The sector provides employment to 45.5 per cent of country's work force and is the single largest private sector occupation.



- Agriculture accounts for about 14.7 per cent of the total export earnings and provides raw material to a large number of Industries (textiles, silk, sugar, rice, flour mills, milk products).
- The agriculture sector acts as a bulwark in maintaining food security and, in the process, national security as well.
- The allied sectors like horticulture, animal husbandry, dairy and fisheries, have an important role in improving the overall economic conditions and health and nutrition of the rural masses.

25.1.2. Problems of Indian Agriculture

- Fragmentation of land holding.
- Existence of small and marginal farmers.
- Regional variation.
- Dependence of seasonal rainfall.
- Low productivity of land.
- Increasing of disguised unemployment.
- Disorder in marketing of Agricultural products.
- Weak land reformation.

25.1.3. Revolutions in Agriculture

Revolution	Related with
Green	Food grain Production
Golden	Fruit Production
Grey	Fertilizer Production
Blue	Fish Production
Black	Petroleum Production
Pink	Prawn Production
Round	Potato Production
Red	Meat/Tomato Production
Silver	Egg/Poultry Production
White	Milk Production
Yellow	Oil seeds Production

Do you know?

According to Global Forest Resource Assessment Report (Food and Agricultural Organization (FAO) 2005), India ranks among the top ten countries in terms of forest area. India has 1.8 % of the global forest area with per capita forests of 0.08 ha.

25.2. CROP AND ITS CLASSIFICATIONS

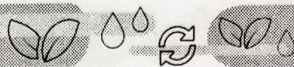
- Agronomy is a Greek word derived from agros meaning 'field' and nomos meaning management. It is a specialized branch in agriculture dealing with crop production and soil management. Crops refer to plants that are grown on a large scale for food, clothing, and other human uses.

25.2.1. Classification based on climate

1. Tropical: Crops grow well in warm & hot climate. E.g. Rice, sugarcane, Jowar etc
2. Temperate: Crops grow well in cool climate. Wheat, Oats, Gram, Potato etc.

25.2.2. Classification Based on growing season

1. Kharif/Rainy/Monsoon crops: The crops grown in monsoon months from June to Oct-Nov, Require warm, wet weather at major period of crop growth, also required short day length for flowering. E.g. Cotton, Rice, Jowar, bajara.
2. Rabi/winter/cold seasons crops: The crops grown in winter season from Oct to March month. Crops grow well in cold and dry weather. Require longer day length for flowering. E.g. Wheat, gram, sunflower etc.
3. Summer/Zaid crops: crops grown in summer month from March to June. Require warm dry weather for major growth period and longer day length for flowering. E.g. Groundnuts, Watermelon, Pumpkins, Gourds.



25.2.3. Agronomic Classification of Crops

Cereals

- Cereals are cultivated grasses grown for their edible starchy grains. Larger grains used as staple food are cereals. Rice, wheat, maize, barley and oats. The important cereal of world is rice, bread wheat, macaroni wheat, emmer wheat, dwarf wheat.

Millets

- They are also annual grasses of the group cereals but they are grown in less area or less important area whose productivity and economics are also less.
- These are staple food of poor people. In India pearl millet is a staple food in Rajasthan Major millets and Minor millets are based on area production and productivity and grain size.

Major millets

Sorghum /Jowar
Pearl Millet /Bajra/cumbu
Finger millet or ragi

Minor millets

1. Fox tail millet
2. Little millet
3. Common millet
4. Barnyard millet
5. Kodomillet

Pulses or Grain Legumes

- Pulses are major source of protein in Indian diet and providing most of the essential amino acids to a certain degree. Economically, pulses are cheapest source of protein.
- It is cultivated to enrich the soil, to utilize the residual moisture and to give revenue in a shorter period.

Red gram
Black gram
Green gram
Cowpea

Bengalgram
Horsegram
Dewgram
Soyabean
Peas or gardenpea
Garden bean

Oil Seed Crops

- These crops are cultivated for the production of oil. Either for edible on industrial or medicinal purpose. They contain more of fat.

Groundnut or peanut
Sesamum or gingelly
Sunflower
Castor
Linseed or flax
Niger
Safflower
Rapeseed & Mustard

- 45 - 50% oil content is present in these seeds.

Sugar Crops

Juice extracted from

1. Sugar stem used for jaggery or sugar
 - Number of by products like Molasses, bagasse, pressmud
 - Molasses used for alcohol and yeast formation
 - Bagasse for paper making and fuel
 - Pressmud used for soil amendment
 - Trash (green leaf + dry foliage) - the waste is used for cattle feed
2. Sugar beet - Tuber for extraction of sugar
 - Tubers and tops are used as a fodder for cattle feed

Starch Crops or Tuber Crops

1. Potato
2. Tapioca or cassava
3. Sweet potato



Fibre Crops

- Epidermal hairs of seed coats is the economic portion
- Lint (cappas - seed) has industrial value (fibre)
- Stalk is of fuel nature, garment purpose, seed for cattle feed and Oil is edible

Cotton

- Karunganni
- Uppam cotton
- American cotton or Cambodium cotton
- Egyptian cotton or Sea island cotton

Stem Fibres

- Jute
- Mesta
- Sun hemp
- Sisal hemp

Narcotics

- Stimulates Nervous System
 - Tobacco
 - Betelvine
 - Arecanut

Forage and Fodder Crops

Forage Crops

- The entire vegetative part is used as green fodder
- the stalks and leaves are the major economic portion for hay making
- Hay is cut into pieces and mixed with concentrated animal feed and is fed to animals

Grasses

- Napier grass
- Para grass
- Bermuda grass
- Guinea grass
- Rhodes grass

Legumes

- Lucerne (Alfalfa)
- Egyptian clover (Berseem)
- Indian clover (Fodder senji)
- Sirato
- Stylo
- Subabul
- Velvet bean

Plantation Crops

- Plants and its
- 1) Tea - leaf; 2) Coffee - seed; 3) Rubber - milk exudation; 4) Cocoa - seed

Spices and Condiments

- Products of crop plants are used to flavor taste and sometime color the fresh preserved food. E.g. ginger, garlic, chili, cumin onion, coriander, cardamom, pepper, turmeric etc.
- Medicinal plants includes cinchona, isabgoli, opium poppy, senna, belladonna, rauwolfra, iycorice.
- Aromatic plants such as lemon grass, citronella grass, palmorsa, Japanese mint, peppermint, rose, jasmine, henna etc.

25.2.4. Classification based on life of duration of crops:

1. Seasonal crops: A crop completes its life cycle in one season. E.g. rice, Jowar, wheat etc.
2. Two seasonal crops: crops complete its life cycle in two seasons. E.g. Cotton, turmeric, ginger.
3. Annual crops: Crops require one full year to complete its life cycle. E.g. sugarcane.
4. Biennial crops: Crops requires two year to complete its life cycle E.g. Banana, Papaya.
5. Perennial crops: crops live for several years. E.g. Fruit crops, mango, guava etc.

25.2.5. Classification based on cultural method/ water:

1. Rain fed: Cultivation of crop mainly based on the availability of rain water. E.g. Jowar, Bajara, Mung etc.



2. Irrigated crops: Crops cultivated with the help of irrigation water. E.g. Chili, sugarcane, Banana, papaya etc.

25.2.6. Classification based on root system

1. Tap root system: The main root goes deep into the soil. E.g. Tur, Grape, Cotton etc.
2. Fiber rooted: The crops whose roots are fibrous shallow & spreading into the soil. E.g. Cereal crops, wheat, rice etc.

25.2.7. Classification based on economic importance

1. Cash crop: Grown for earning money. E.g. Sugarcane, cotton.
2. Food crops: Grown for raising food grain for the population and & fodder for cattle. E.g. Jowar, wheat, rice etc.

25.2.8. Classification based on No. of cotyledons

Monocots or monocotyledons: Having one cotyledon in the seed. E.g. all cereals & Millets.

2. Dicots or dicotyledonous: Crops having two cotyledons in the seed. E.g. all legumes & pulses and almost all the trees.

25.2.9. Classification based on length of photoperiod required for floral initiation

- Most plants are influenced by relative length of the day & night, especially for floral initiation, the effect on plant is known as photoperiodism depending on the length of photoperiod required for floral ignition, plants are classified as:
 1. Short-day plants: Flower initiation takes place when days are short less than ten hours. E.g. rice, Jowar, green gram, black gram etc.
 2. Long day's plants: require long days are more than ten hours for floral initiation. E.g. Wheat, Barley, etc.
 3. Day neutral plants: Photoperiod does not have much influence for phase change for these plants. E.g. Cotton, sunflower, etc.

25.3. TILLAGE

- Tillage is the mechanical manipulation of soil with tools and implements for obtaining conditions

ideal for seed germination, seedling establishment and growth of crops.

- **Tilth:** It is the physical condition of soil obtained out of tillage (or) it is the result of tillage. The tilth may be a coarse tilth, fine tilth or moderate tilth. Based on the requirement of crops being grown and the soil where we are cultivating.
- **Types of tillage:** Tillage operations may be grouped into
 1. On season tillage
 2. Off-season tillage
- **On-season tillage:** Tillage operations that are done for raising crops in the same season or at the onset of the crop season are known as on season tillage.
- **Preparatory tillage:** This refers to tillage operations that are done to prepare the field for raising crops. It consists of deep opening and loosening of the soil to bring about a desirable tilth as well as to incorporate or uproot weeds and crop stubble when the soil is in a workable condition.

Types of preparatory tillage

1. Primary tillage
 2. Secondary tillage
- **Primary tillage:** The tillage operation that is done after the harvest of crop to bring the land under cultivation is known as primary tillage. Ploughing is the opening of compact soil with the help of different ploughs. Country plough, mould board plough, borse plough, tractor and power tiller are used for primary tillage.
 - **Secondary tillage:** The tillage operations that are performed on the soil after primary tillage to bring a good soil tilth are known as secondary tillage. Secondary tillage consists of lighter or finer operation which is done to clean the soil, break the clods and incorporate the manure and fertilizers. Harrowing and planking is done to serve those purposes
 - **Dry tillage:** Dry tillage is practiced for crops that are sown or planted in dry land condition having sufficient moisture for germination of seeds. This



is suitable for crops like broadcasted paddy, jute, wheat, oilseed crops, pulses, potato and vegetable crops.

- **Wet or puddling tillage:** The tillage operation that is done in a land with standing water is called wet or puddling tillage. Puddling operation consists of ploughing repeatedly in standing water until the soil becomes soft and muddy. Puddling creates an impervious layer below the surface to reduce deep percolation losses of water and to provide soft seed bed for planting rice.
- **Off-season tillage:** Tillage operations done for conditioning the soil suitably for the forthcoming main season crop are called off-season tillage. Off season tillage may be
 1. Post harvest tillage
 2. Summer tillage
 3. Winter tillage
 4. Fallow tillage
- **Special purpose tillage:** Tillage operations intended to serve special purposes are said to be special purpose tillage. They are,
 - 1) sub soiling,
 - 2) levelling,
 - 3) clean tillage,
 - 4) blind tillage,
 - 5) wet tillage and
 - 6) zero tillage.
- **Sub soiling:** To break the hard pan beneath the plough layer special tillage operations (chiselling) are performed to reduce compaction. Sub soiling is essential once in four to five years where heavy machineries are used for field operations, seeding, harvesting, transporting etc.

Advantages

1. greater volume of soil may be obtained for cultivation of crops
2. excess water may percolate downward to recharge the permanent water table
3. reduce runoff and soil erosion

4. roots of crop plants can penetrate deeper to extract moisture from the water table

- **Clean tillage:** It refers to working of the soil of the entire field in such a way no living plant is left undisturbed. It is practiced to control weeds, soil borne pathogen and pests.
- **Blind tillage:** It refers to tillage done after seeding or planting the crop (in a sterile soil) either at the pre - emergence stage of the crop plants or while they are in the early stages of growth so that crop plants (cereals, tuber crops etc.) do not get damaged, but extra plants and broad leaved weeds are uprooted.
- **Zero tillage (No tillage):** In this, new crop is planted in the residues of the previous crop without any prior soil tillage or seed bed preparation and it is possible when all the weeds are controlled by the use of herbicides.

Advantages of Zero tillage

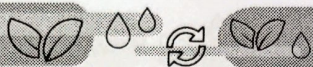
1. Zero tilled soils are homogenous in structure with more number of earthworms
2. Organic matter content increases due to less mineralization
3. Surface runoff is reduced due to presence of mulch

Disadvantages

1. Higher amount of nitrogen has to be applied for mineralization of organic matter in zero tillage
2. Perennial weeds may be a problem
3. High number of volunteer plants and buildup of pests

25.4. CROPPING

- **Cropping intensity:** Number of crops cultivated in a piece of land per annum is cropping intensity. In Punjab and Tamil Nadu the cropping intensity is more than 100 per cent i.e. around 140-150%. In Rajasthan the cropping intensity is less.



Cropping pattern

- The yearly sequence and spatial arrangement of crops and fallow on a given area is called cropping pattern

Cropping system

- The cropping pattern used on a farm and its interactions with farm resources, other farm enterprises, and available technology which determine their makeup.
- **Multiple cropping:** Growing more than two crops in a piece of land in a year in orderly succession. It is also called as intensive cropping. It is used to intensify the production. It is possible only when assured resources are available (land, labour, capital and water)

- **Double cropping:** Growing two crops a year in sequence. Example: Rice - Pulse

- **Triple cropping:** Growing three crops a year in sequence. Example: Rice - Rice - Pulse

- **Quadruple cropping:** Growing four crops in a year in sequence

- **Monoculture:** Repetitive growing of the same sole crop in the same land.

- **Mono cropping:** Continuous production of one and the same crop year after year or season after season is called mono cropping.

- **Sole cropping:** One crop variety grown alone in a pure stand at normal density.

Sequential cropping

- Growing of two or more crops in sequence on the same field in a year. The succeeding crop is planted after the preceeding crop has been harvested
 - The crop intensification is done in time dimension
 - Ex: Rice-rice-cotton
- **Relay cropping** Growing the succeeding crop when previous crop attend its maturity stage-or-sowing

of the next crop immediately before the harvest of the standing crops.

E.g. 1) Paddy-Lucerne.

2) Rice-Cauliflower-Onion-summer gourds.

Ratoon cropping

- Raising a crop with regrowth coming out of roots or stocks of the harvested crop
 - Ex: Sugarcane (8 ratoons in Cuba)
 - Banana – one plant crop followed by two ratoon crops normally
 - Sorghum and Lucerne fodder- many ratoons 1st cutting 70 DAS and thereafter every 35-40 days.
 - Pineapple crop is extensively ratooned.

Intercropping

- Growing two or more crops simultaneously with distinct row arrangement on the same field at the same time.
 - **Base crop:** primary crop which is planted/sown at its optimum sole crop population in an intercropping situation.
 - **Intercrop:** This is a second crop planted in between rows of base crop with a view to obtain extra yields with intercrop without compromise in the main crop yields

Advantages of Intercropping

- Better use of growth resources including light, nutrients and water
- Suppression of weeds
- Yield & stability - even if one crop fails due to unforeseen situations, another crop will yield and provides some secured income
- Successful intercropping gives higher equivalent yields (yield of base crop + yield of intercrop), higher cropping intensity
- Reduced pest and disease incidences



- Improvement of soil health and agro-eco system

Examples of Inter cropping

- Ex: Maize + Cowpea 1:1
- Sorghum + Redgram 2:2
- Groundnut + Redgram 6:1
- Potato + Mustard 3:1
- Wheat + Mustard 8:1

Types of intercropping

- Strip intercropping
- Parellel cropping
- Synergistic cropping
 - Additive Series (Paired row intercropping)
 - Replacement Series
- Multi storey cropping
- Relay intercropping
- Alley cropping

Strip intercropping

- Growing of two or more crops simultaneously in strips wide enough to permit independent cultivation but narrow enough for the crops to interact each other.
- Ex: 6 rows of groundnut and 4 rows of redgram in strips

Parellel cropping

- Growing of two crops simultaneously which have different growth habits and no competition among themselves
- Ex: Blackgram with maize
- Soybean with cotton

Synergistic Cropping

- Yields of both crops are higher than of their pure crops on unit area basis
- Ex: Sugarcane + Potato

Multi storey cropping

- Cultivation of more than two crops of different heights simultaneously on a piece of land in any certain period
 - Ex: Coconut + Pepper + cocoa + pineapple

Relay intercropping

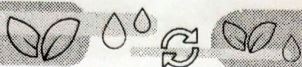
- In a long duration base crop, growing two sets of intercrops one after another is called relay intercropping
 - Ex; Redgram - base crop 180 days
 - Groundnut/onion/coriander-I set of intercrops
 - Samai/ thenai/panivaragu- 2nd set of intercrops

Alley cropping

- Alley cropping is a system in which food crops are grown in alleys formed by hedge rows of trees or shrubs. The essential feature of the system is that hedge rows are cut back at planting and kept pruned during cropping to prevent shading and to reduce competition with food crops.
 - Ex: Subabul raised at 6 m row spacing
 - The space between two rows called alleys
 - The intercrops are raised in the alley space
 - E.g. cotton, sorghum, blackgram

Mixed cropping

- Growing of two or more crops simultaneously intermingled without row arrangement is known as mixed cropping
- It is a common practice in most of dryland tracts in India
- Seeds of different crops are mixed in certain proportion and are sown
- The objective is to meet the family requirement of cereals, pulses and vegetables, it is a subsistence farming
- Ex: Sorghum, Bajra and cowpea are mixed and broadcasted in rainfed conditions (with low rainfall situations) to avoid complete crop failures and with ascertaining the minimum yields



Difference between inter cropping and mixed cropping

Inter cropping	Mixed cropping
The main objective of inter cropping is to utilise the space between rows of main crop and to produce more grain per unit area	The main objective of mixed cropping is insurance against crop failure.
There is no competition between main and inter crop (subsidiary crop)	There is competition between component crops. Here all crops are given equal importance and care. Hence, there is no difference between component crops
In inter cropping, the main crop may be a long duration one and the inter crop may be a short duration/early maturing one	Crops may or may not be of same duration
Main and inter crops are sown in definite row arrangement	There is no specific row arrangement. Generally crop seeds are mixed and broadcasted
The sowing time of both the crops may or may not be the same. Sometimes the main crops is sown earlier than the inter crop	The sowing time of component crops is same.

FARMING SYSTEMS

Definitions

- Farm – is a piece of land with specific boundaries, where crop and livestock enterprises are taken up under common management
- Farming – is the process of harnessing solar energy in the form of economic plant and animal products
- System – a set of components which are interdependent and interacting

Wetland farming

- Wet land – soils flooded or irrigated through lake, pond or canal and land is always in submerged condition
- Wetland farming: is the practice of growing crops in soils flooded through natural flow of water for most part of the year

Garden land/ irrigated Dry land farming

- Garden land – soils irrigated with ground water sources

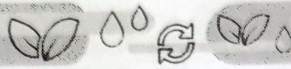
- Garden land farming: Growing crops with supplemental irrigation by lifting water from underground sources.

Dry land farming

- Dry land – soils purely depends rainfall for moisture
- Dry land farming: is the practice of crop production entirely depending upon rainfall and the moisture conserved in the soil
- This is practiced in areas where annual rainfall is less than 750mm. The crops may face moisture stress frequently due to erratic distribution or failure of monsoon

Rain fed farming

- Crop production in areas where rainfall is more than 750mm (i.e assured rainfall areas). Here moisture stress will be minimum. Soil conservation is given more importance



Mixed Farming

- Mixed farming is defined as a system of farming on a particular farm which includes crop production, raising live stock, poultry, fisheries, bee keeping etc. to sustain and satisfy as many needs of the farmer as possible. Subsistence is important objective of mixed farming. While higher profitability without altering ecological balance is important in farming system.

Advantages:

- It offers highest return on farm business, as the byproducts of farm are properly utilized.
- It provides work throughout year.
- Efficient utilization of land, labour, equipment and other resources.
- The crop by-products such as straw, fodder etc. is used for feeding of livestock and in return they provide milk.
- Manures available from livestock to maintain soil fertility.
- It helps in supplying all the food needs of the family members.

Specialized Farming

The farm in which 50% or more income of total crop production is derived from a single crop is called specialized farming

Diversified Farming

- A diversified farming has several production enterprises or sources of income but no source of income equal as much as 50% of the total income. It is also called as general farming.

25.6. CROP ROTATION

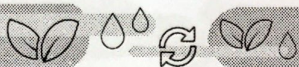
- Growing of different crops on a piece of land is a preplanned succession. The principle of crop rotation is to utilise the available resources to the fullest extent in order to harvest the maximum in a unit land without affecting the soil health.
- Ex- Rice-Red Gram -Banana

25.6.1. Principles of crop rotation

- Leguminous crops should be grown before non-leguminous crops because legumes fix atmospheric N into the soil and add organic matter to the soil.
- Crops with tap roots (deep rooted like cotton) should be followed by those which have fibrous (shallow rooted crops like sorghum or maize) root system. This facilitates proper and uniform use of nutrients from the soil.
- More exhaustive crops should be followed by less exhaustive crops because crops like potato, sugarcane, maize etc. need more inputs such as better tillage, more fertilizers, greater number of irrigation etc.
- Selection of crop should be based on need or demand
- Crops of same family should not be grown in succession because they act as alternate hosts for insect pests and diseases
- The selection of crops should suit farmers financial conditions
- The crop selected should also suit to the soil and climatic condition

25.7. SUSTAINABLE AGRICULTURE

- It is a form of agriculture aimed at meeting the needs of the present generation without endangering the resource base of the future generations. It is considered as a system of cultivation with the use of manure, crop rotation and minimal tillage and with minimum dependence on synthetic fertilizers, pesticides and antibiotics. It is a balanced management system of renewable resources including soil, wildlife, forests, crops, fish, livestock, plant genetic resources and ecosystems without degradation and to provide food, livelihood for current and future generations maintaining or improving productivity and ecosystem services of these resources.
- Sustainable agriculture has to prevent land degradation and soil erosion. It has to replenish



nutrients and control weeds, pests and diseases through biological and cultural methods.

- Degradation of natural resources is the main issue threatening sustainable development of agriculture.

25.8. ORGANIC FARMING

- Organic farming is a production system where all kinds of agricultural products are produced organically, including grains, meat, dairy, eggs, fibers such as cotton, flowers, and processed food products
- Organic farming avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives.

Components of organic farming

- It largely rely upon crop rotations, crop residues, animal manure, legumes, green manure, on/off farm organic wastes, mechanical cultivation, mineral bearing rocks and aspects of biological control of pests and diseases to maintain soil productivity and tilth to supply plant nutrients.

It is a sustainable agricultural system which maintains and improves soil fertility so as to guarantee for adequate food security in the future.

2. It relies upon resources from its own area which is not depended much on imported resources.
3. It helps in maintaining the stability of natural ecosystem

Concepts

1. Building up of biological soil fertility

Organic Vs. Inorganic Fertilizers

Organic Fertilizers	Inorganic Fertilizer
Three common forms: animal manure, green manure and compost.	Does not add humus to the soil, resulting in less ability to hold water and support living organisms (earthworms, beneficial bacterial, and fungi, etc.)

2. Control of pests, diseases and weeds through development of an ecological balance within the system and by use of bioagents and various cultural techniques.
3. It recycles all wastes and manure within the farm.

- Eco-farming: Farming in relation to ecosystem.
- Biological farming: Farming in relation to biological diversity.
- Biodynamic farming: Farming which is biologically organic and ecologically sound and sustainable farming.

Organic farming -Components:

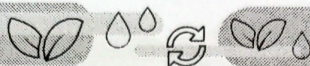
- The components of organic farming are
 - i) Organic manures
 - ii) Non- chemical weed control and
 - iii) Biological pest and disease management.

Principles:

- The three interrelated principles are
 - i) Mixed farming
 - ii) Crop rotation
 - iii) Organic cycle optimization

Eco-farming:

- It is the farming mutually reinforcing ecological approaches to food production. It aims at the maintenance of soil chemically, biologically and physically the way nature would do if left alone. Soil would then take proper care of plants growing on it. Feed the soil, not the plant is the watchword and slogan of ecological farming.



Organic Fertilizers	Inorganic Fertilizer
Improves soil texture, adds organic nitrogen, and stimulates beneficial bacterial and fungi.	Lowens oxygen content of the soil thereby keeping fertilizer from being taken up efficiently.
Improves water-holding capacity of soil.	Supplies only a limited number of nutrients (usually nitrogen and phosphorus)
Helps to prevent erosion	Requires large amounts of energy to produce, transport, and apply. Release nitrous oxide (N ₂ O) —a greenhouse gas.

25.9. PERMACULTURE

- Bill Mollison, an Australian ecologist, and one of his students, David Holmgren, coined the word “permaculture” in 1978. It is a contraction of “permanent agriculture” or “permanent culture.”
- It is defined as a design system for creating sustainable human environments. It uses ecology as the basis for designing integrated systems of food production, housing, appropriate technology, and community development.
- Permaculture is built upon an ethic of caring for the earth and interacting with the environment in mutually beneficial ways.
- A central theme in Permaculture is the design of ecological landscapes that produce food. Emphasis is placed on multi-use plants, cultural practices such as sheet mulching and trellising, and the integration of animals to recycle nutrients and graze weeds.

25.9.1. Characteristics

- It is one of the most holistic, integrated systems analysis and design methodologies found in the world.
- It can be applied to create productive ecosystems from the human- use standpoint or to help degraded ecosystems recover health and wildness.
- It can be applied in any ecosystem, no matter how degraded.
- It values and validates traditional knowledge and experience.

- Incorporates sustainable agriculture practices and land management techniques and strategies from around the world
- It is a bridge between traditional cultures and emergent earth-tuned cultures.
- It promotes organic agriculture, which does not use pesticides.
- It aims to maximize symbiotic and synergistic relationships between site components.
- It's design is site specific, client specific, culture specific

25.10. INTEGRATED FARMING SYSTEM

- Integration of farm enterprises such as cropping systems, animal husbandry, fisheries, forestry etc. for optimal utilisation of resources bringing prosperity to the farmer. According to the availability of land, type of land, water, capital, resources, technical skill of the farmer, market facilities etc., and the components of farming system are to be chosen and adopted for better results.

25.10.1. Benefits of Integrated Farming System

- Steady income other than income from regular cropping
- Risk coverage due to subsidiary allocation in the event of unexpected crop failures
- Employment opportunity
- Higher productivity
- Augmented returns and recycling of organics



- Easily adopted by marginal and submarginal farmers
- General uplift of farm activities
- Better utilisation of land, labour, time and available manures in the farm.

ELEMENTS REQUIRED IN PLANT GROWTH

1. Macronutrients:

- Based on the relative abundance in plants, viz., Nitrogen (N); Phosphorous (P), Potassium (K), Sulfur (S), Calcium (Ca) and Magnesium (Mg)

2. Micronutrients:

- Their concentration is very small. They are also referred to as minor elements.
- Iron (Fe); Zinc (Zn); Manganese (Mg), Copper (Cu), Boron (B), Chlorine (Cl) and Molybdenum (Mo). In some plants, other than the above, Sodium (Na), Cobalt (Co), Vanadium (Va), Nickel (Ni) and Silicon (Si) are considered as essential micronutrients

Nitrogen (N)

- N is an essential constituent of proteins and is present in many other compounds of great physiological importance in plant metabolism
 - N is an integral part of chlorophyll, which is primary observer of light energy needed for photosynthesis.
 - N also imparts vigorous vegetative growth and dark green colour to plants.
- Phosphorus (P) is an essential part of the enzymes which help the crop to fix light energy. It forms an integral part of nucleic acids, the carriers of genetic information, and is important in stimulating root growth
 - Potassium (K) is involved in processes which ensure carbon assimilation and the transportation of photosynthates throughout the plant for growth and the storage of sugars and proteins. The potassium ion is also important for water

regulation and uptake. Furthermore, the presence of potassium in sufficient amounts ensures resistance to frost, drought and certain diseases

- Magnesium occurs in chlorophyll and is also an activator of enzymes,
- Sulphur forms part of two essential amino acids which are among the many building blocks of protein. It is also found in vitamin B₁ and in several important enzymes.
- Calcium is required for plant growth, cell division and enlargement. The growth of root and shoot tips and storage organs is also affected by calcium as it is a component of cell membranes. Calcium is also vital for pollen growth and to prevent leaf fall

Manures

- Manures are plant and animal wastes that are used as source of plant nutrients. They release nutrients after their decomposition. Manures can be grouped into bulky organic manures and concentrated organic manures

Fertilizers

- Fertilizers are industrially manufactured chemical containing plant nutrients. Nutrient content is higher in fertilizers than organic manures and nutrients are released almost immediately

Role of manures

- Organic manures bind the sandy soil and improve its water holding capacity.
- They open the clayey soil and help in aeration better root growth.
- They add plant nutrients in small percentage and also add micro nutrients which are essential for plant growth. The microbial activity is increased which helps in releasing plant nutrients in available form. e.g. bulky organic manures- FYM, compost from organic waste, night soil, sludge, sewage, sheep folding, green manures, concentrated organic manures- oilcakes (edible, non-edible), blood meal, fish meal, bone meal.



4. Organic manures should be incorporated before the sowing or planting because of slow release of nutrients

Classification of Organic manures

Farm Yard Manure

- This is the traditional manure and is mostly readily available to the farmers. Farm yard manure is a decomposed mixture of Cattle dung and urine with straw and litter used as bedding material and residues from the fodder fed to the cattle..

Compost Manure

- Compost is well rotted organic manure prepared by decomposition of organic matter. Composting is largely a biological process in which micro-organisms of both types, aerobic (require oxygen for deep development) and anaerobic (functions in absence of air or free oxygen), decompose the organic matter and lower down the C:N ratio of refuse. The final product of composting is well rotted manure known as compost

Sheep and Goat droppings

- It is also valuable organic manure. It contains about 0.5 to 0.7 % N, 0.4 to 0.6% P_2O_5 and 0.3 -1.0% K_2O . It is effective to all types of crops

Concentrated organic manures

Oil cakes

- There are many varieties of oil cakes which contains not only nitrogen but also some P and K along with large percentage of organic matter. These oil cakes are of two types.
 - i. Edible oil cakes- suitable for feeding cattle.
 - ii. Non-edible oil cakes-not suitable for feeding cattle.
- Oil cakes are quick acting organic manure. Though they are insoluble in water, their nitrogen became quickly available to plants in about a week or in 10 days after application.

Bone Meal

- Bones from slaughter houses, carcasses of all animals and from meat industry constitute bone meal, which is the oldest phosphatic fertilizer used. It also contains some N.

Fish meal

- Fish manure or meal is processed by drying non-edible fish, carcasses of fish and wastes from fish industry. It contains 4.0-10.0 % nitrogen, 3.0-9.0 % P and 0.3 to 1.5 % K. Fishmeal is quick acting organic manure and is suitable for application to all crops on all soils.

Green Manuring

- It is a practice of ploughing in the green plant grown in the field or adding green plants from outside and incorporating them into the soil for improving the physical structure as well as fertility of the soil. E.g.: Sannhemp, Dhaicha, Pillipesara, Shervi, Urd, Mung, Cowpea, Be Senji, etc.

Green leaf Manuring

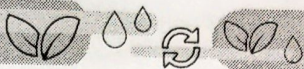
- Green leaf manuring refers to adding the green leaf and green twigs from legume plants or trees to a field and then incorporating them into the soil by ploughing. E.g.: Glyricidia, wild Dhaicha, Karanj (pongamia), leucaena.

Bio-fertilizers

- Bio-fertilizers are the preparations containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic micro-organisms used for application to seed or composting areas with the objective of increasing the numbers of such micro-organisms and accelerating those microbial processes which augment the availability of nutrients that can be easily assimilated by plants. Bio-fertilizers harness atmospheric nitrogen with the help of specialized micro-organisms which may be free living in soil or symbiotic with plants.

Nitrogen fixers

1. Symbiotic: - Rhizobium, inoculants for legumes.



2. Non-symbiotic: - For cereals, millets and vegetables.

a) Bacteria:-

- i) Aerobic:- Azotobacter, Azomonas, Azospirillum.
- ii) Anaerobic:- Clostridium, chlorobium
- iii) Facultative anaerobes- Bacillus, E. coli

b) Blue green algae- Anabaena, Nostoc

- A. Phosphate solubilizing micro-organisms.
- B. Cellulolytic and lignolytic micro organisms.
- C. Sulphur dissolving bacteria.
- D. Azolla.

Integrated Nutrient Management (INM)

- Judicious combination of organic, inorganic and biofertilizers which replenishes the soil nutrients which are removed by the crops is referred as Integrated Nutrient Management system
- To sustain the productivity of different crops and cropping systems, efficient nutrient management is vital. There is a need to develop more efficient, economic and integrated system of nutrient management for realizing high crop productivity without diminishing soil fertility

2 WEEDS

Weeds are unwanted and undesirable plant that interfere with utilization of land and water resources and thus adversely affect crop production and human welfare

- They are gregarious in nature compared to crop plants.

Harmful effects of weeds

1. Weeds compete with main crop for space, light, moisture and soil nutrients thus causing reduction in yield.
2. Affect quality of farm produce, livestock products such as milk and skin
3. Act as alternate host for pests and pathogens

4. Cause health problems to human beings eg; Parthenium causes allergy

5. Increase cost of cultivation due to weeding problem

6. Aquatic weeds transpire large quantity of water, obstruct flow of water

7. Reduce the land value (if cynodon, parthenium are present in the land)

8. Some weeds are poisonous to livestock.

Beneficial effects of weeds

1. Weed as soil binders
2. as manure
3. as human food
4. as fodder
5. Weed as fuel
6. Weed as mats and screens
7. Weed as medicine: Many weeds have great therapeutic properties and used as medicine. Eg.

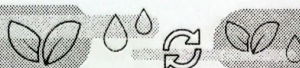
Phyllanthus niruri	-	Jaundice
Eclipta alba	-	Scorpion sting
Centella asiatica	-	Improves memory
Cynodon dactylon	-	Asthma, piles
Cyperus rotundus	-	Stimulates milk secretion

8. Weed as indicators: Weeds are useful as indicators of good and bad soils. Cynodon occurs in rich soils while Cymbopogon denotes poor light soil and Sedges are found in ill-drained soils

- Genetically modified crops (GM crops, or biotech crops) are plants, the DNA of which has been modified using genetic engineering techniques, which are then used in agriculture.

Watershed Management

- A watershed is an area of land and water bounded by a drainage divide within which the surface runoff collects and flows out of the watershed through a single outlet into a larger river (or) lake.



Micro Irrigation

- Micro irrigation is defined as the methods in which low volume of water is applied at low pressure & high frequency. The system has extensive network of pipes at operated at low pressure. At pre-determined spacing outlets are provided for emission water generally known as emitters.

Sprinkler Irrigation

- In the sprinkler method of irrigation, water is sprayed into the air and allowed to fall on the ground surface somewhat resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles.

Drip irrigation:

- Drip irrigation is also called trickle irrigation and involves dripping water onto the soil at very low rates from a system of small diameter plastic pipes fitted with outlets called emitters.
- Water is applied close to plants so that only part of the soil in which the roots grow is wetted, unlike surface and sprinkler irrigation, which involves wetting the whole soil profile.

Terracing:

- "A terrace is an embankment or ridge of earth constructed across a slope to control runoff and minimize soil erosion".
- It reduces the length of the hill side slope, thereby reducing sheet and rill erosion and prevents formation of gullies.

25.13. SOIL

Soils are a thin layer on top of most of Earth's land surface. This thin layer is a basic natural resource and deeply affects every other part of the ecosystem. Soils are composed of three main ingredients: minerals of different sizes, organic materials from the remains of dead plants and animals, and open space that can be filled with water or air. A good soil for

growing most plants should have about 45% minerals (with a mixture of sand, silt, and clay), 5% organic matter, 25% air, and 25% water.

Soils develop in response to several factors:

1. **Parent material:** This refers to the rock and minerals from which the soil derives. The natural of the parent rock, which can be either native to the area or transported to the area by wind, water, or glacier, has a direct effect on the ultimate soil profile.
2. **Climate:** This is measured by precipitation and temperature. It results in partial weathering of the parent material, which forms the substrate for soil.
3. **Living organisms:** These include the nitrogen-fixing bacterial *Rhizobium*, fungi, insects, worms, snails, etc., that help to decompose litter and recycle nutrients.
4. **Topography:** This refers to the physical characteristics of the location where the soil is formed. Topographic factors that affect a soil's profile include drainage, slope direction, elevation and wind exposure.

With sufficient time, a mature soil profile reaches a state of equilibrium. Feedback mechanisms involving both abiotic and biotic factors work to preserve the mature soil profile. The relative abundance of sand, silt, and clay is called the soil texture.

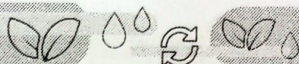
Soil Components

Clay: very fine particles. Compacts easily. Forms large, dense clumps when wet. Low permeability to water; therefore, upper layers become waterlogged.

Gravel: Coarse particles. Consists of rock fragments.

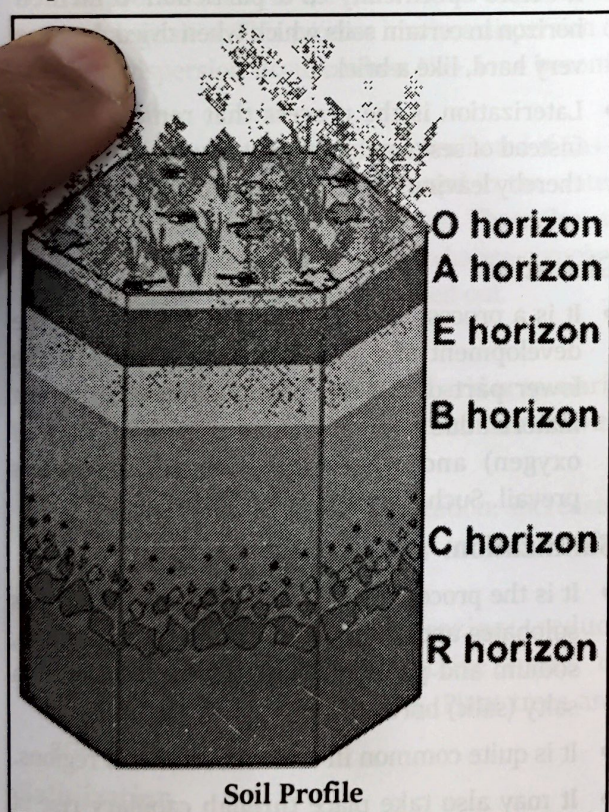
Loam: About equal mixtures of clay, sand, silt, and humus. Rich in nutrients. Holds water but does not become waterlogged.

Sand: Sedimentary material coarser than silt. Water flows through too quickly for most crops. Good for crops and plants requiring low amounts of water.



Slit: Sedimentary material consisting of very fine particles between the size of sand and clay. Easily transported by water.

- Soil is a natural body of mineral and organic constituents differentiated into horizons usually unconsolidated, of variable depth which differs among themselves as well as from the underlying parent material in morphology, physical makeup, chemical properties and composition and biological characteristics.
- Soil profile: The vertical section of the soil showing the various layers from the surface to the unaffected parent material is known as a soil profile. The various layers are known as horizons.
- There are 5 master horizons in the soil profile. Not all soil profiles contain all 5 horizons; and so, soil profiles differ from one location to another.



- The 5 master horizons are represented by the letters: O, A, E, B, and C.
- **O:** The O horizon is a surface horizon that is comprised of organic material at various stages of

decomposition. It is most prominent in forested areas where there is the accumulation of debris fallen from trees.

- **A:** The A horizon is a surface horizon that largely consists of minerals (sand, silt, and clay) and with appreciable amounts of organic matter. This horizon is predominantly the surface layer of many soils in grasslands and agricultural lands.
- **E:** The E horizon is a subsurface horizon that has been heavily leached. Leaching is the process in which soluble nutrients are lost from the soil due to precipitation or irrigation. The horizon is typically light in color. It is generally found beneath the O horizon.
- **B:** The B horizon is a subsurface horizon that has accumulated from the layer(s) above. It is a site of deposition of certain minerals that have leached from the layer(s) above.
- **C:** The C horizon is a subsurface horizon. It is the least weathered horizon. Also known as the saprolite, it is unconsolidated, loose parent material.
- **R:** Unweathered rock exists below the parent material.
- **Soil texture** refers to the relative proportion of particles or it is the relative percentage by weight of the three soil separates viz., sand, silt and clay or simply refers to the size of soil particles.
- **Loam:** A type of soil texture with good water holding capacity and drainage suitable for cultivation of variety of crops.
- **Soil structure:** The arrangement and organization of primary and secondary particles in a soil mass is known as soil structure.

Saline soils

- Saline soils are characterised by higher amount of water soluble salt, due to which the crop growth is affected.



Sodic soils

- Sodic soils are characterised by the predominance of sodium in the complex with the exchangeable sodium percentage exceeding 15 per cent and the pH more than 8.5.

Acid soils

- Acid soils are characteristically low in pH (< 6.0). Predominance of H^+ and Al^{3+} cause acidity resulting in deficiency of P, K, Ca, Mg, Mo and B.

Sandy soils

- Sandy soils are containing predominant amounts of sand resulting in higher percolation rates and nutrient losses.
- Alkaline soil: A soil with pH above 7, usually above 8.5 are considered alkaline. Alkaline soils often occur in arid regions that receive less than 25 inches of rain per year.
- Calcariuos soil- Soils with kankar nodules in the plough zone and subsoil.
- Alfisol: Soils with grey to brown surface horizons, medium to high supply of bases and B horizons of illuvial clay accumulation. These soils formed mostly under forest or savanna vegetation in climates with slight to pronounced seasonal moisture deficit.
- Aridisol: Minerals soils that have an aridic moisture regime. These are desert soil.

Podzolization:

- It is a process of soil formation resulting in the formation of Podzols and Podzolic soils.
- podzolization is the negative of calcification. The calcification process tends to concentrate calcium in the lower part of the B horizon, whereas podzolization leaches the entire solum of calcium carbonates.
- The other bases along with calcium are also removed and the whole soil becomes distinctly acidic. In fact, the process is essentially one of the processes of acid leaching.

The National Green Tribunal (NGT) has set up an eight-member experts' panel to study various aspects of the proposed Rs.5,242 crore Renuka dam. It would provide drinking water to Delhi and areas of Haryana and Uttar Pradesh such as Faridabad and Noida. The project will come up across the Giri river, a tributary of the Yamuna, in Sirmaur district.

Laterization:

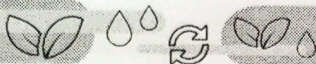
- The term laterite is derived from the word later meaning brick or tile and was originally applied to a group of high clay Indian soils found in Malabar hills of Kerala, Tamil Nadu, Karnataka and Maharashtra.
- It refers specifically to a particular cemented horizon in certain soils which when dried, become very hard, like a brick.
- Laterization is the process that removes silica, instead of sesquioxides from the upper layers and thereby leaving sesquioxides to concentrate in the solum.

Gleization:

- It is a process of soil formation resulting in the development of a glei (or gley horizon) in the lower part of the soil profile above the parent material due to poor drainage condition (lack of oxygen) and where waterlogged conditions prevail. Such soils are called hydro orphic soils.

Salinization:

- It is the process of accumulation of salts, such as sulphates and chlorides of calcium, magnesium, sodium and potassium, in soils in the form of a salty (salic) horizon.
- It is quite common in arid and semi arid regions.
- It may also take place through capillary rise of saline ground water and by inundation with seawater in marine and coastal soils.
- Salt accumulation may also result from irrigation or seepage in areas of impeded drainage.



Desalinization:

- It is the removal of excess soluble salts by leaching from horizons or soil profile (that contained enough soluble salts to impair the plant growth) by ponding water and improving the drainage conditions by installing artificial drainage network.

Solonization or Alkalization:

- The process involves the accumulation of sodium ions on the exchange complex of the clay, resulting in the formation of sodic soils (Solonetz).
- All cations in solution are engaged in a reversible reaction with the exchange sites on the clay and organic matter particles.

Solodization or dealkalization:

The process refers to the removal of Na^+ from the exchange sites. This process involves dispersion of clay. Dispersion occurs when Na^+ ions become hydrated.

- Much of the dispersion can be eliminated if Ca^{++} and or Mg^{++} ions are concentrated in the water, which is used to leach the soonest. These Ca and Mg ion can replace the Na on exchange complex, and the salts of sodium are leached out.

Desertification

- Definition: Productive potential of arid or semiarid land falls by at least 10% due to human activity and/or climate change.
- Symptoms: Loss of native vegetation; increased wind erosion; salinization; drop in water table; reduce surface water supply.
- Remediation: Reduce overgrazing; reduce deforestation; reduce destructive forms of planting, irrigation, and mining. Plant trees and grasses to hold soil.

Salinization

- Definition: Water that is not absorbed into the soil and evaporates leaves behind dissolved salts in topsoil.
- Symptoms: Stunted crop growth; lower yield; eventual destruction of plant life.

- Remediation: Take land out of production for a while; and/or install underground perforated drainage pipes; flush soil with freshwater into separate lined evaporation ponds; plant halophytes (salt-loving plants) such as barley, cotton, sugar beet and/or semi-dwarf wheat.

Water logging

- Definition: Saturation of soil with water resulting in a rise in the water table.
- Symptoms: Saline water envelops deep roots killing plants; lowers productivity; eventual destruction of plant life.
- Remediation: Switch to less water-demanding plants in areas susceptible to water logging; utilize conservation-tillage farming; plant water logging-resistant trees with deep roots; take and out of production for a while; and/or install pumping stations with drainage pipes that lead to catchment-evaporation basins.
- Loam soils generally contain more nutrients and humus than sandy soils, have better infiltration and drainage than silty soils and are easier to till than clay soils.
- If the topsoil is brown or black, it is rich in nitrogen and is good for crops. If the topsoil is gray, yellow, or red, it is low in organic matter and poor for crops.

25.14. STAGES OF SOIL EROSION

Splash erosion

- Splash erosion is the first stage of the erosion process. It occurs when raindrops hit bare soil. The explosive impact breaks up soil aggregates so that individual soil particles are 'splashed' onto the soil surface.

Sheet erosion

- Sheet erosion refers to the uniform movement of a thin layer of soil across an expanse of land devoid of vegetative cover. Raindrops detach soil particles, which go into solution as runoff occurs and are transported downstream to a point of deposition.



Rill erosion

- When sheet flows begin to concentrate on the land surface, rill erosion occurs. While sheet erosion is generally invisible, rill erosion leaves visible scouring on the landscape. This type of erosion occurs when the duration or intensity of rain increases and runoff volumes accelerate.

Gully erosion

- Rill erosion evolves into gully erosion as duration or intensity of rain continues to increase and runoff volumes continue to accelerate. A gully is generally defined as a scoured out area that is not crossable with tillage or grading equipment.
- **Ammonification:** Production of ammonia as a result of the biological decomposition of organic nitrogen compounds.
- **Border cropping:** is growing of crops on the border areas of the plot or field
- Ex; Safflower as border crop in potato
- **Border strip irrigation:** It is an efficient method of irrigation close growing crops. In this method the field is divided by low flat levels into series of strips, each of which is flooded separately.
- **Allelopathy:** is defined as direct or indirect harmful effect of one plant over the other crop species through the exudation of toxic substances from the roots or the decomposition of crop residues
- **C:N ratio:** The ratio of the weight of organic C to the weight of total N in the soil.
- **Check basin:** It is a method of irrigation with beds and channel for retaining water to form a pond
- **Heaving:** Injury to plants caused by lifting upward of the plant along with soil from its normal position in temperate regions where snowfall is common
- **Contour farming:** is the farming practice of ploughing across a slope following its elevation contour lines.
- **Cover crops:** crops which are grown to cover the soil in order to reduce the loss of the moisture from the soil due to leaching and erosion.

- **Critical stage of irrigation:** the period or the stage of development of life cycle of the crop when it is most sensitive to moisture stress, results in yield loss
- **Hard pan:** It is a hard and impermeable layer formed in the soil profile by accumulation of materials such as salts, clay etc which impedes drainage
- **Growth regulators:** Organic substances which in minute amount may participate in the control of growth processes Ex: Auxins, Cytokinins
- **Heliophytes:** Plants of sun loving species, require intense light for normal development Ex: Rice, Wheat, Cotton, Sugarcane
- **Sciophytes:** Plants which are shade loving and require less light intensity
- **Heliotropism:** It is the movement of the plant parts towards the sun Ex: Sunflower
- **Geotropism:** A growth movement in response to gravity. Eg Groundnut peg penetration into the soil
- **Herbicide:** A chemical used for killing inhibiting the growth of unwanted plants Atrazine
- **Insecticide:** It is the chemical used for killing the insects: Endosulfan
- **Hidden hunger:** Is the condition where plants do not exhibit visual symptoms of deficiency for the short supply of particular nutrients but will result in yield losses
- **Humus:** A brown or black organic substance consisting of partially or wholly decayed vegetable or animal matter that provides nutrients for plants and increases the ability of soil to retain water
- **Mulching:** Practice of covering the soil surface with materials like plant residues, straw, leaves or plastic film to reduce evaporation, restrict weed growth and maintain the soil temperature
- **Puddling:** It is the ploughing operation carried out in stagnated water conditions to create an impervious layer below the plough pan



- **Shifting cultivation:** It is the old practice of cutting and clearing of forest for cultivating crops for a certain period of time as long as the soils having fertility
- **Subsidiary farming:** Settled Farming in river banks and streams in addition to gathering & hunting
- **Subsistence farming:** Raising the crops only for family needs and not for commercial: "Grow it and eat it"

Miyawaki Method for Creating Forests

- Miyawaki is a technique pioneered by Japanese botanist Akira Miyawaki, that helps build dense, native forests.
- The approach is supposed to ensure that plant growth is 10 times faster and the resulting plantation is 30 times denser than usual.
- It involves planting dozens of native species in the same area, and becomes maintenance-free after the first three years.
- urban forest at the office of the CAG in New Delhi was made by this technique

System of Rice Intensification (SRI)

- System of Rice Intensification (SRI) emerged in the 1980's as a synthesis of locally advantageous rice production practices encountered in Madagascar by Fr Henri de Laulanie
- SRI is a combination of several practices those include changes in nursery management, time of transplanting, water and weed management. It emphasizes altering of certain agronomic practices of the conventional way of rice cultivation. All these new practices are together known as System of Rice Intensification (SRI).
- Principle - 'More with Less'
- SRI is not a fixed package of technical specifications, but a system of production with four main components, viz., soil fertility management, planting method, weed control and water (irrigation) management. Rice yield increased with less water and with reduction in chemical inputs.